# STUDY OF ARGENTINA WEATHER

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by

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Submitted in partial fulfillment of the requirements for the degree of Master of Science in Meteorology

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February 6, 1942


Salta
La Quiaca
Puerto Aguirre
Florianapolis
Santiago
Cristo Redentor
Villa Ortuzar
(Buenos Aires)
Chos Malal
Esquel
Trelew
Magallanes
Ushuaia
40
50
90
80
70
60
50
40
30
20

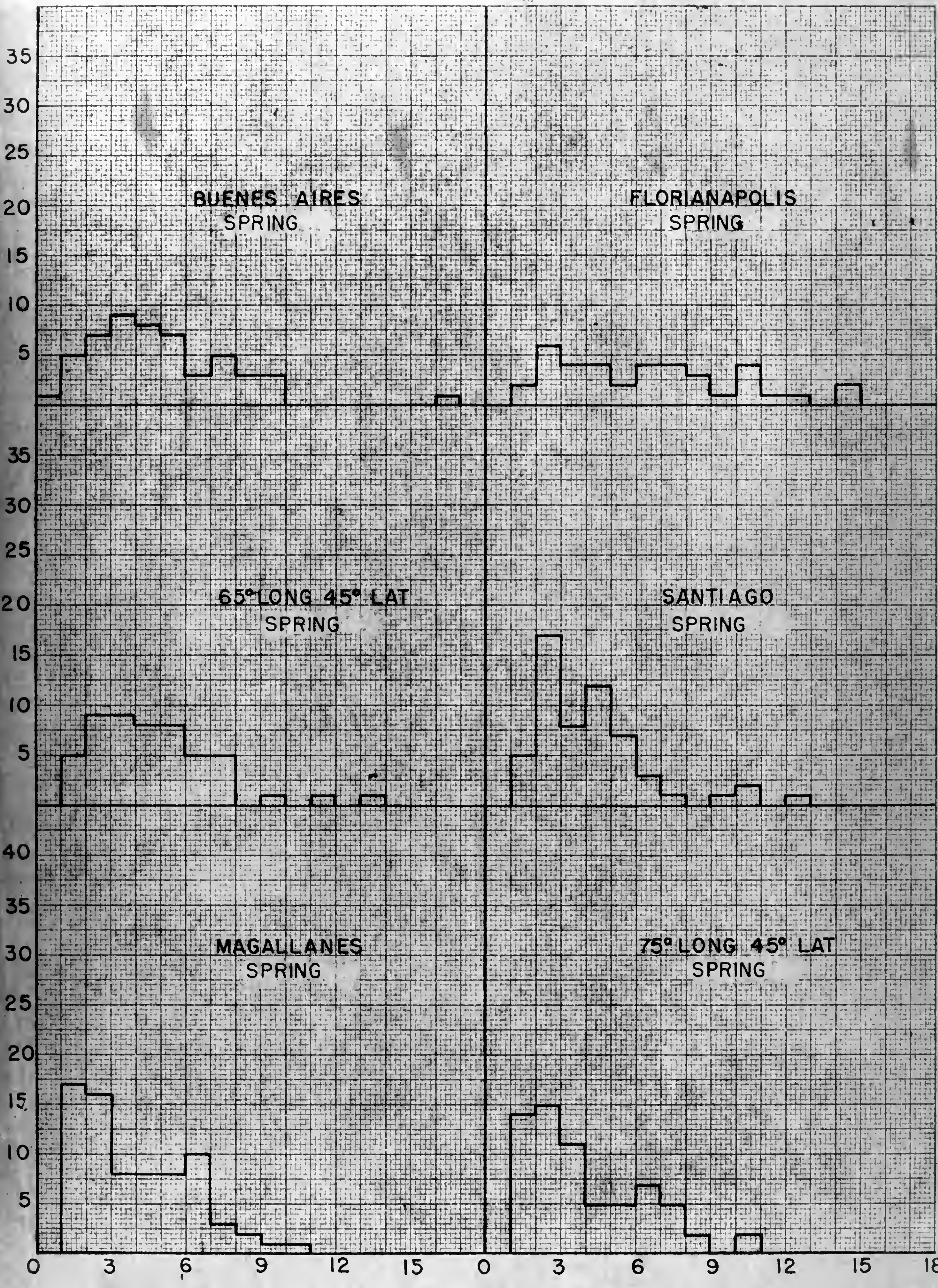
TROUGH PASSAGES

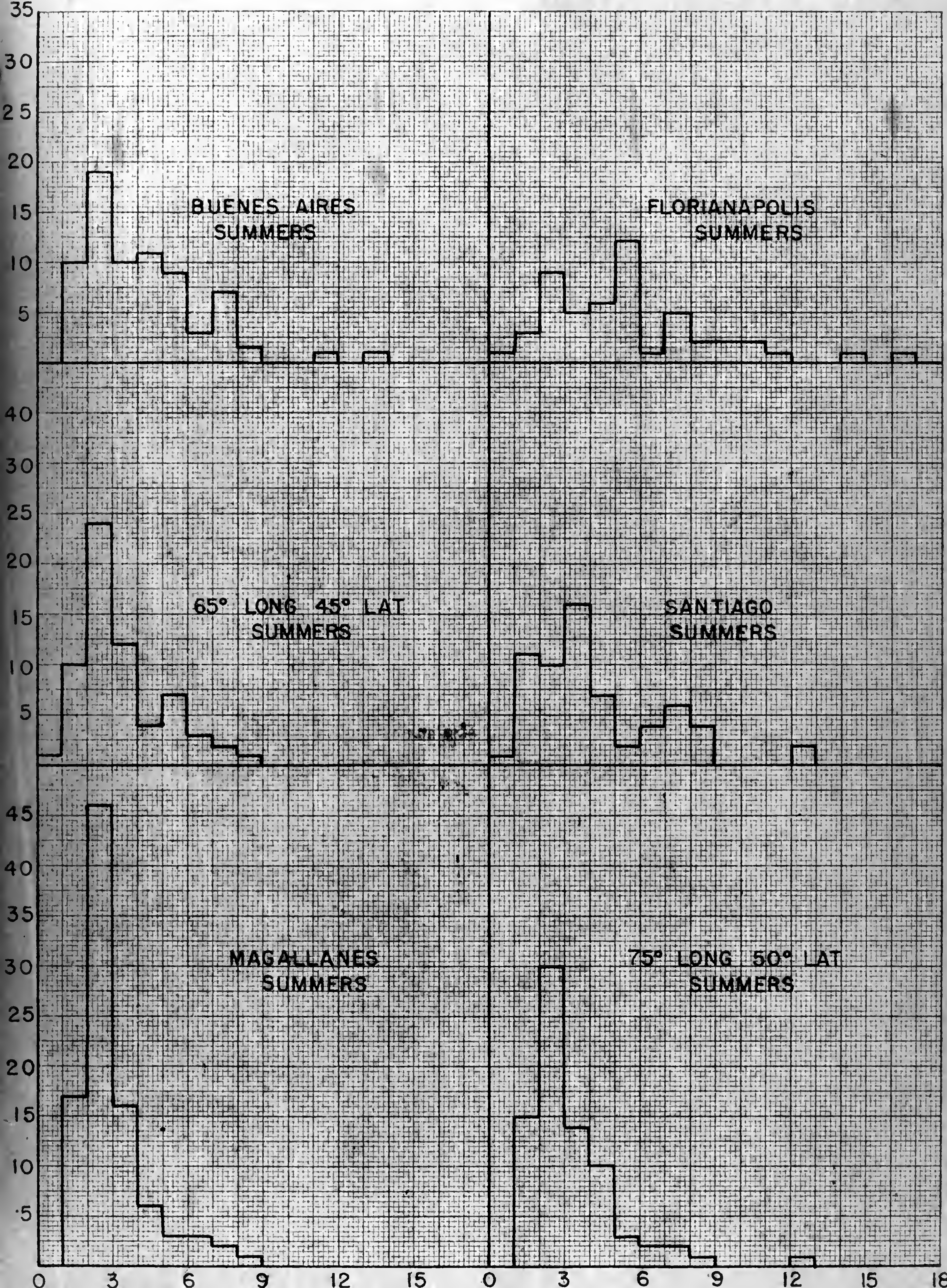
Data covering the period from January 1938, to September 1941, was used in making a study of trough passages in South America. Results of trough passages were shown for each season of the year and also for the whole year. The places observed for trough passages were: Santiago, Chile; Buenes Aires, Argentina; Magallanes, Argentina; Florinapolis, Brazil; 65° longitude, 45° latitude; and 75° longitude, 50° latitude.

In using the data, the data of each trough passage across each station was tabulated. The period was found by taking the number of days between each trough passage.

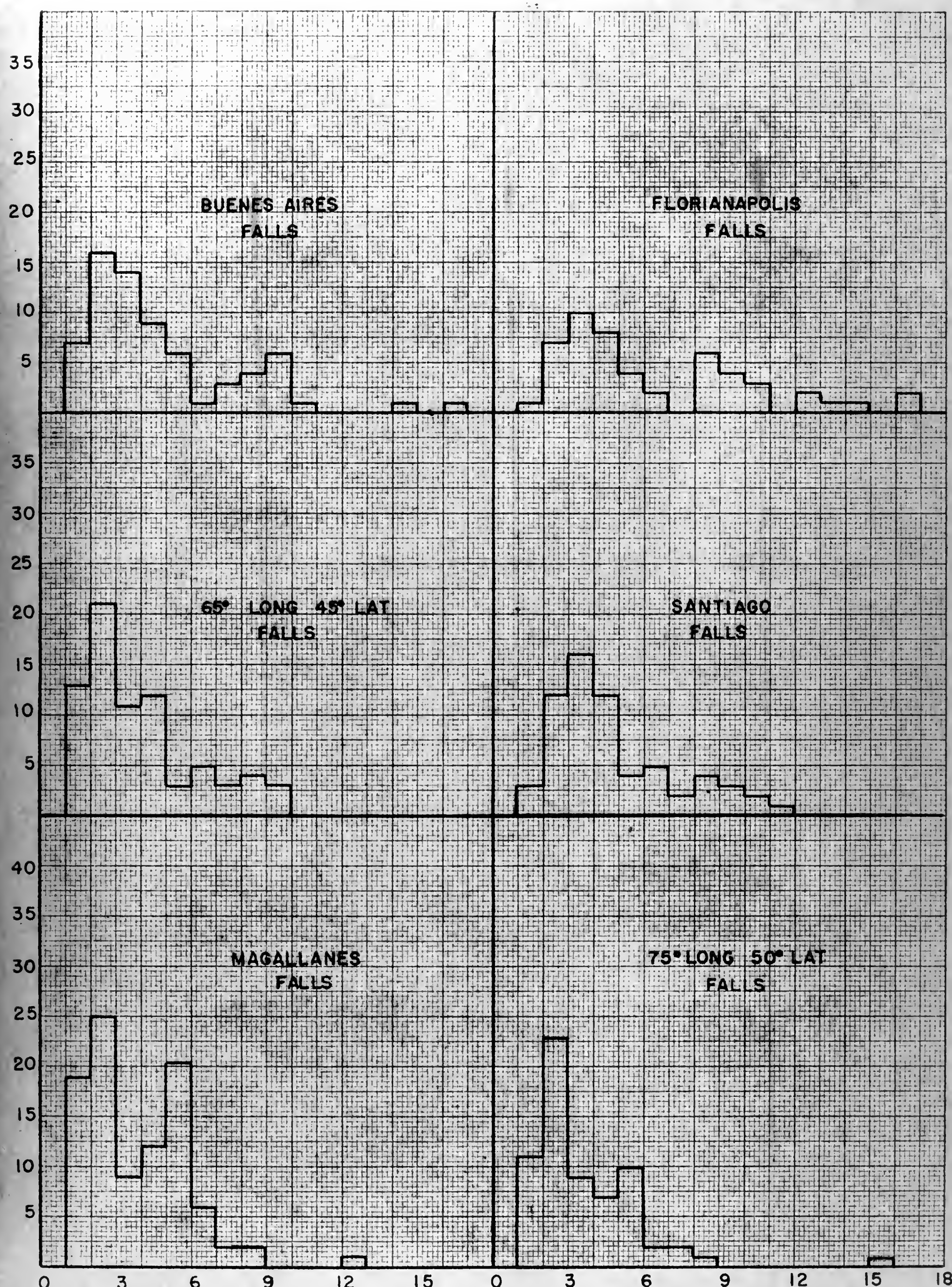
A pronounced three day period was found in the southern part of South America. The farther north the station, the less pronounced the three day period. The period was less pronounced nearer the equator because there the stations were out of the effect of the westerlies. The three day period was less pronounced on the east coast since the trough died out as it passed across the country. In some cases the trough was strong enough to pass across the continent. At 65° longitude, 45° latitude the peak was somewhat smaller than at 75° longitude, 50° latitude, though still definite at 3 days even after passing over the range of 12,000 feet mountains.

Charts were drawn for the percentage of total trough passages occurring in three and six day periods for the four seasons, also for the total number of passages. The highest percentage of the three day periods was again in the southern tip.

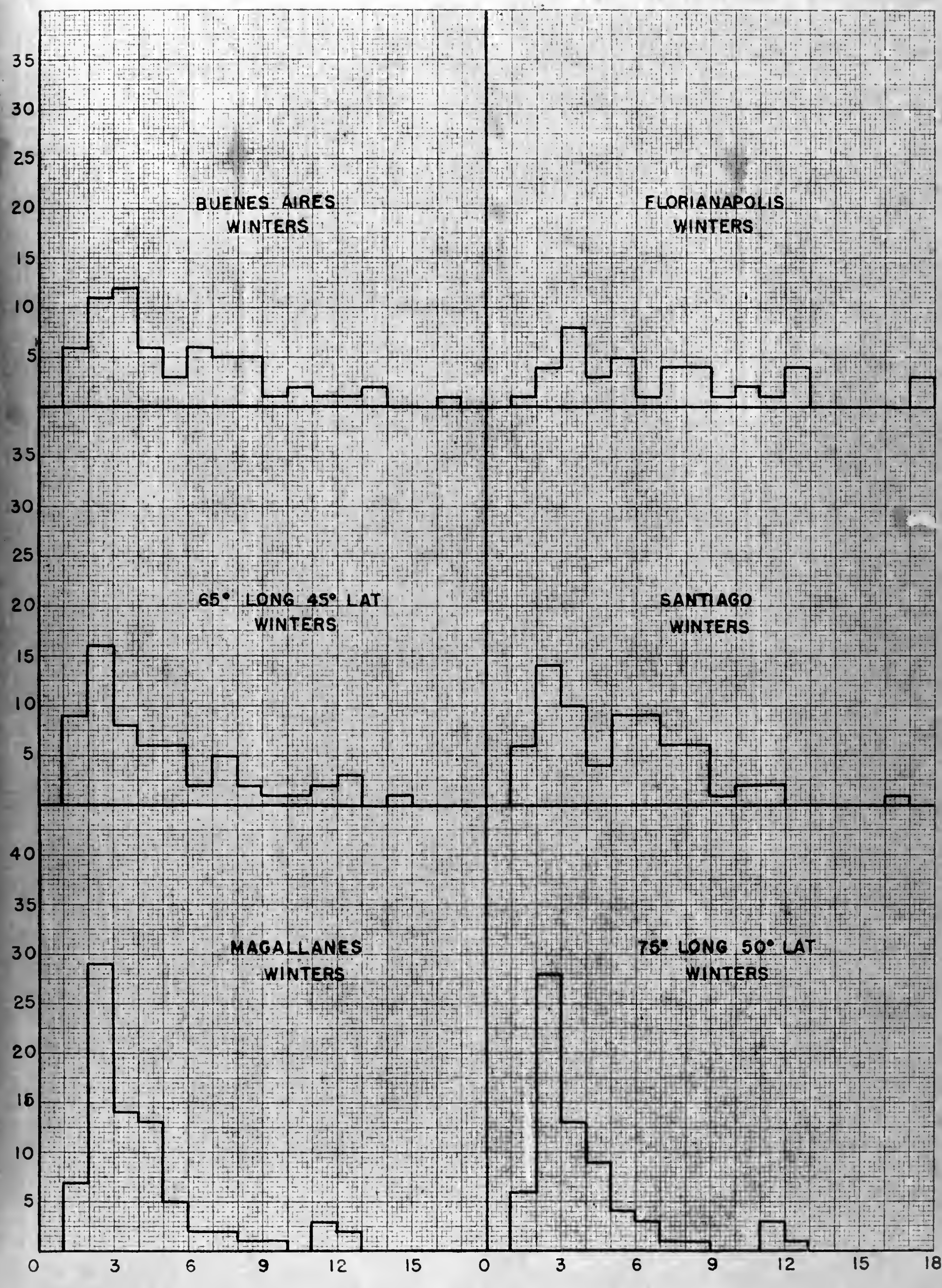

BUENES AIRES
SPRING
FLORIANAPOLIS
SPRING
65° LONG 45° LAT
SPRING
SANTIAGO
SPRING
MAGALLANES
SPRING
75° LONG 45° LAT
SPRING
35
30
25
20
15
10
5
40
0
3
6
9
12
15
18

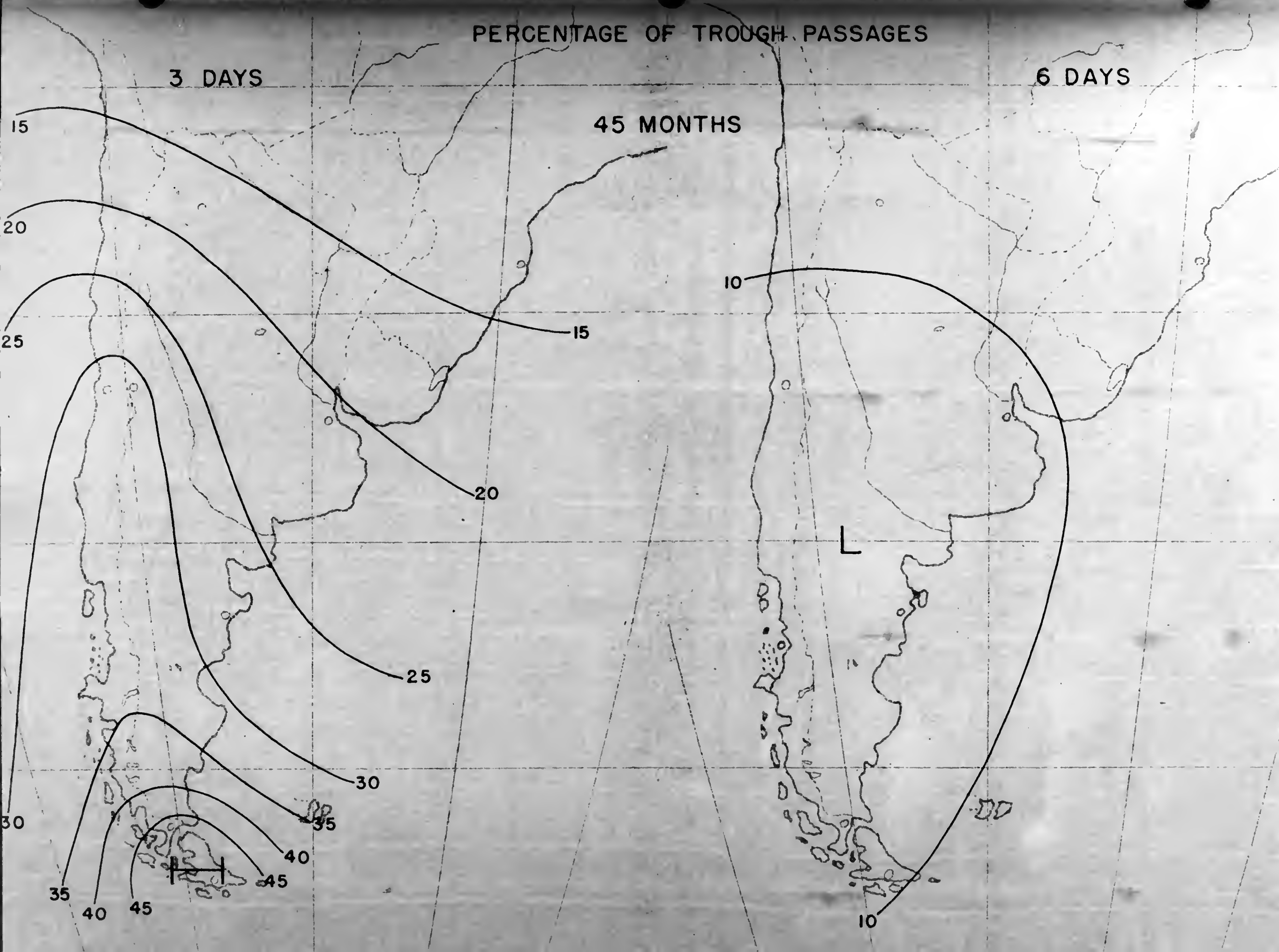

BUENES AIRES
SUMMERS
FLORIANAPOLIS
SUMMERS
65° LONG 45° LAT
SUMMERS
SANTIAGO
SUMMERS
MAGALLANES
SUMMERS
75° LONG 50° LAT
SUMMERS
0
3
6
9
12
15
18


BUENES AIRES
45 MONTHS
FLORIANAPOLIS
45 MONTHS
65° LONG 45° LAT
45 MONTHS
SANTIAGO
45 MONTHS
MAGALLANES
45 MONTHS
75° LONG 50° LAT
45 MONTHS
0 3 6 9 12 15
0 3 6 9 12 15 18
10 20 30 40 50 60 70 80 90

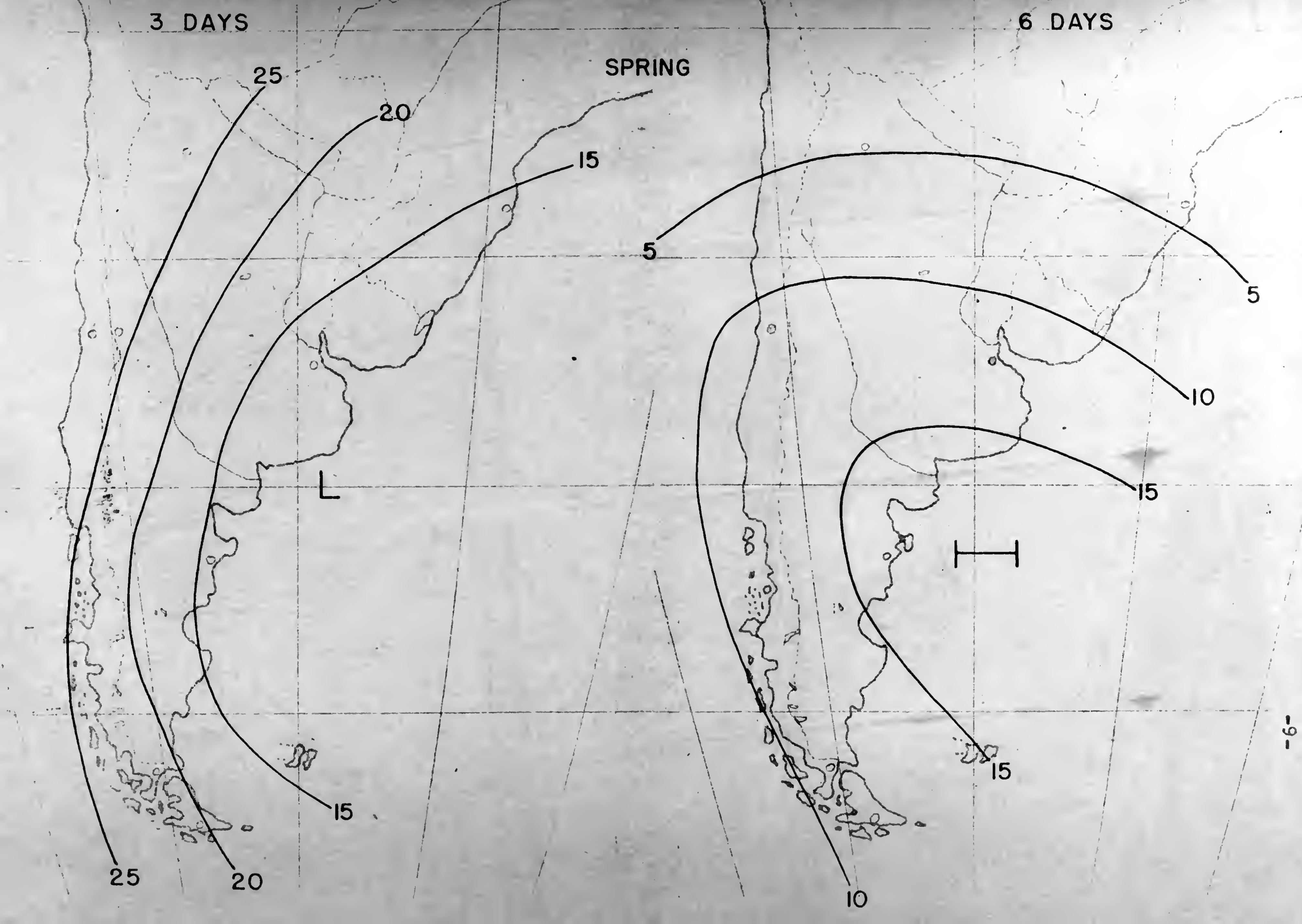


BUENES AIRES
FALLS
FLORIANAPOLIS
FALLS
65° LONG 45° LAT
FALLS
SANTIAGO
FALLS
MAGALLANES
FALLS
75° LONG 50° LAT
FALLS

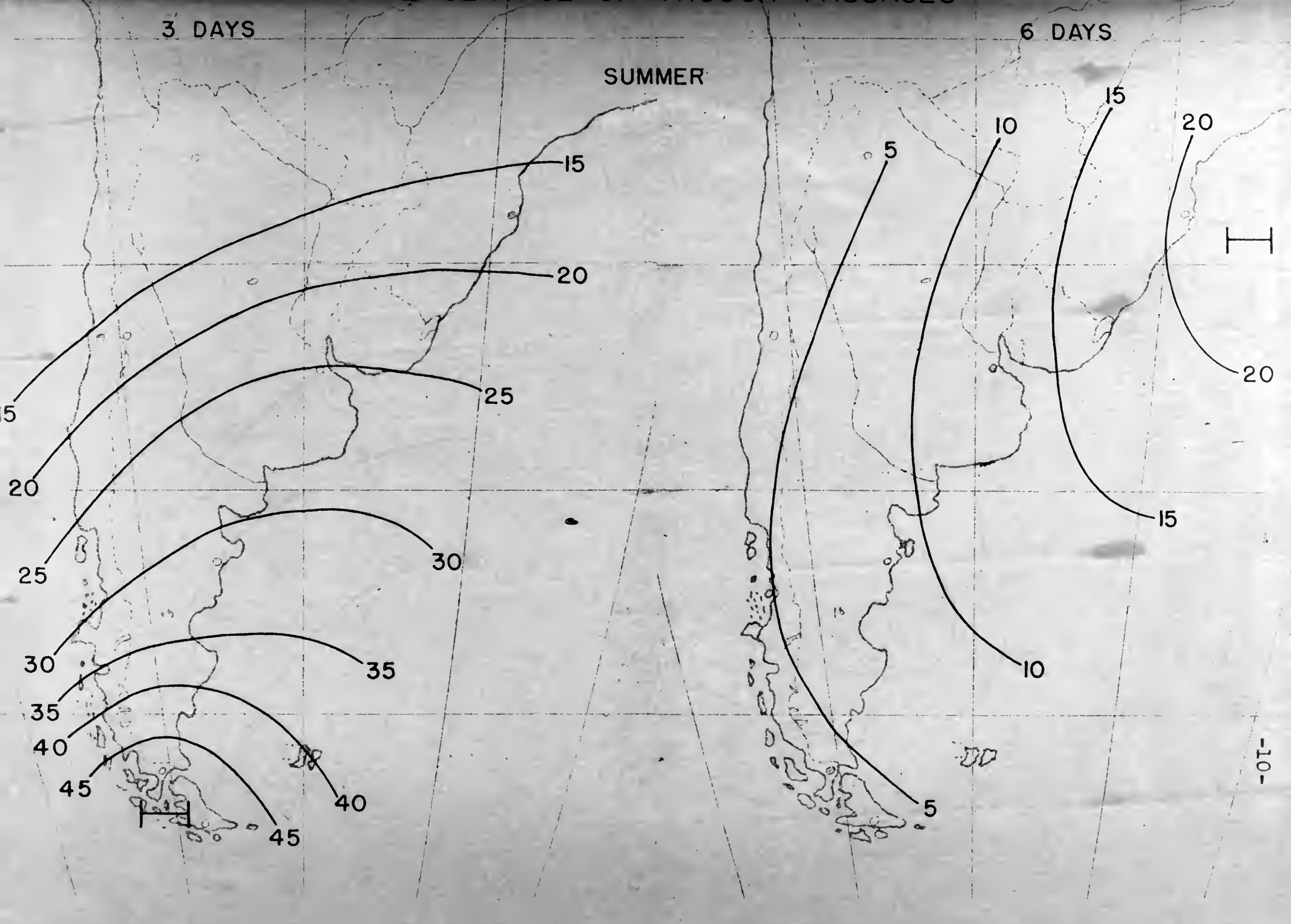

BUENES AIRES
WINTERS
FLORIANAPOLIS
WINTERS
65° LONG 45° LAT
WINTERS
SANTIAGO
WINTERS
MAGALLANES
WINTERS
75° LONG 50° LAT
WINTERS
35
30
25
20
15
10
5
40
0
3
6
9
12
15
18


PERCENTAGE OF TROUGH PASSAGES
3 DAYS
6 DAYS
45 MONTHS
15
20
25
30
35
40
45
10
L

# PERCENTAGE OF TROUGH PASSAGES



PERCENTAGE OF ROUGH PASSAGES



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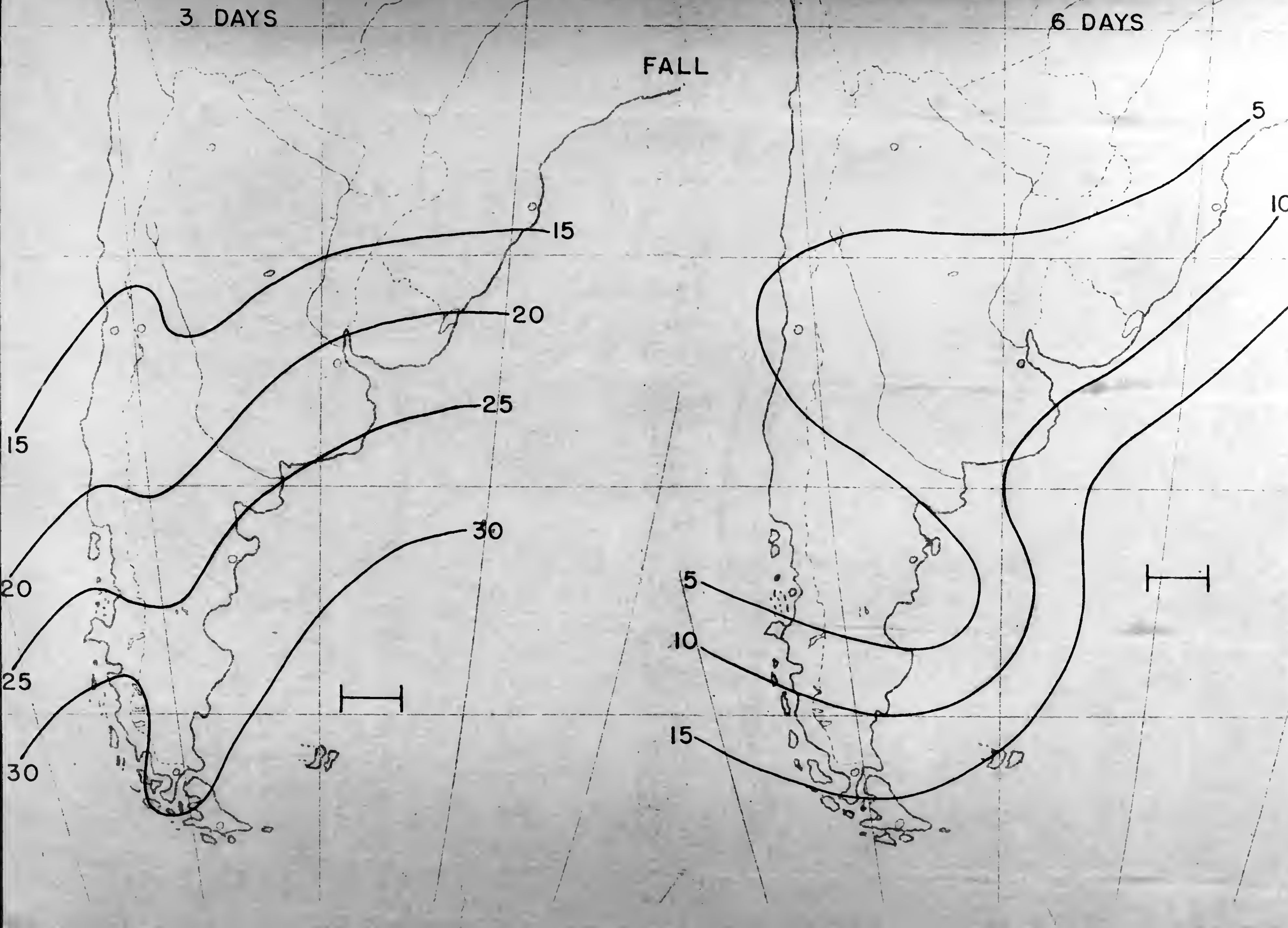
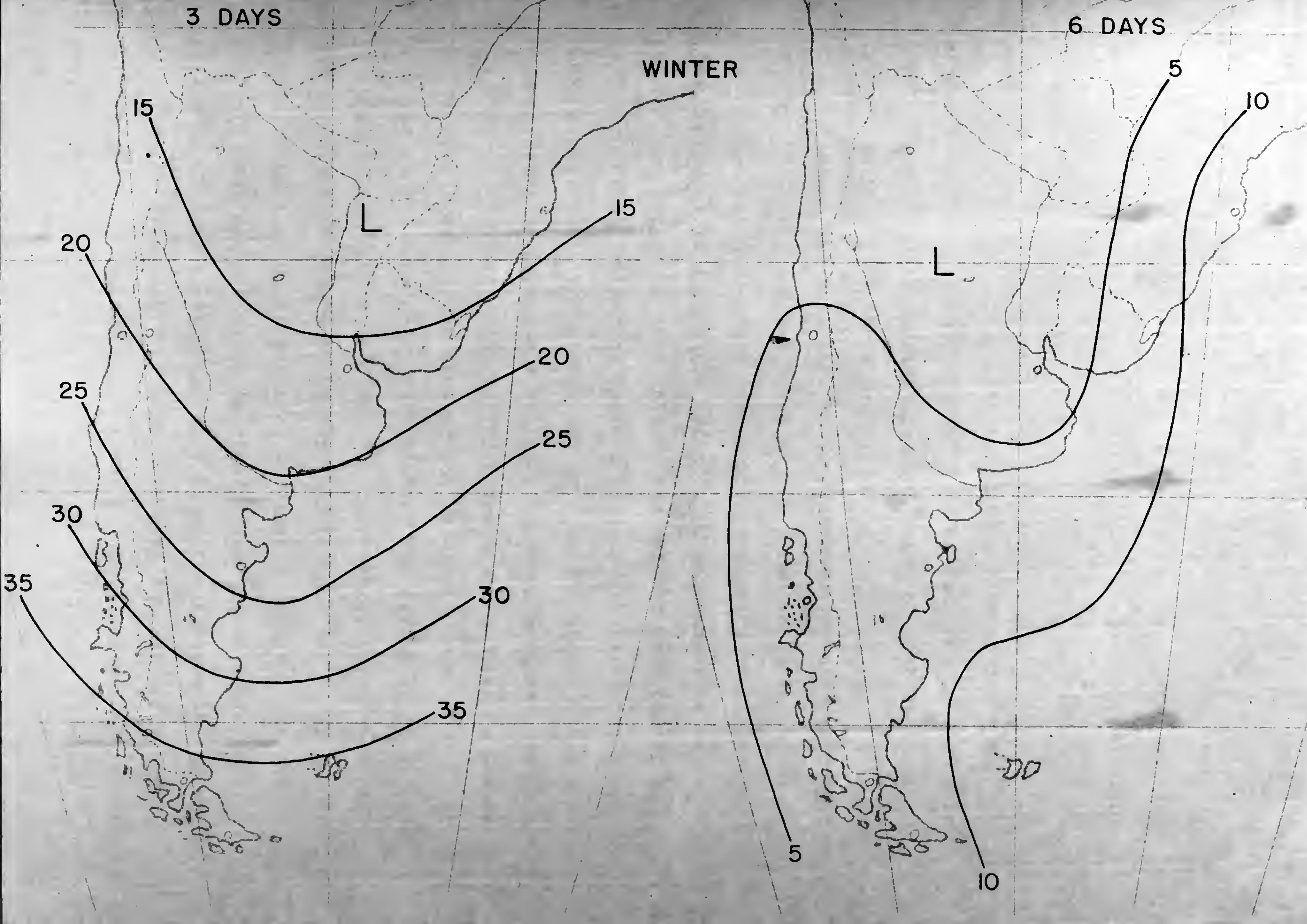


PERCENTAGE OF TROUGH PASSAGES



PRECIPITATION

This study had for its primary purpose the determination of the interval between storm periods in Argentina. By choosing seven stations to give the best coverage of the country the data was gathered for three years and nine months starting with January 1, 1938.

The method used to gather the data was to tabulate all storms no matter the amount of precipitation. The periods were tabulated between the maximum precipitation of each storm no matter the length of the storm period.

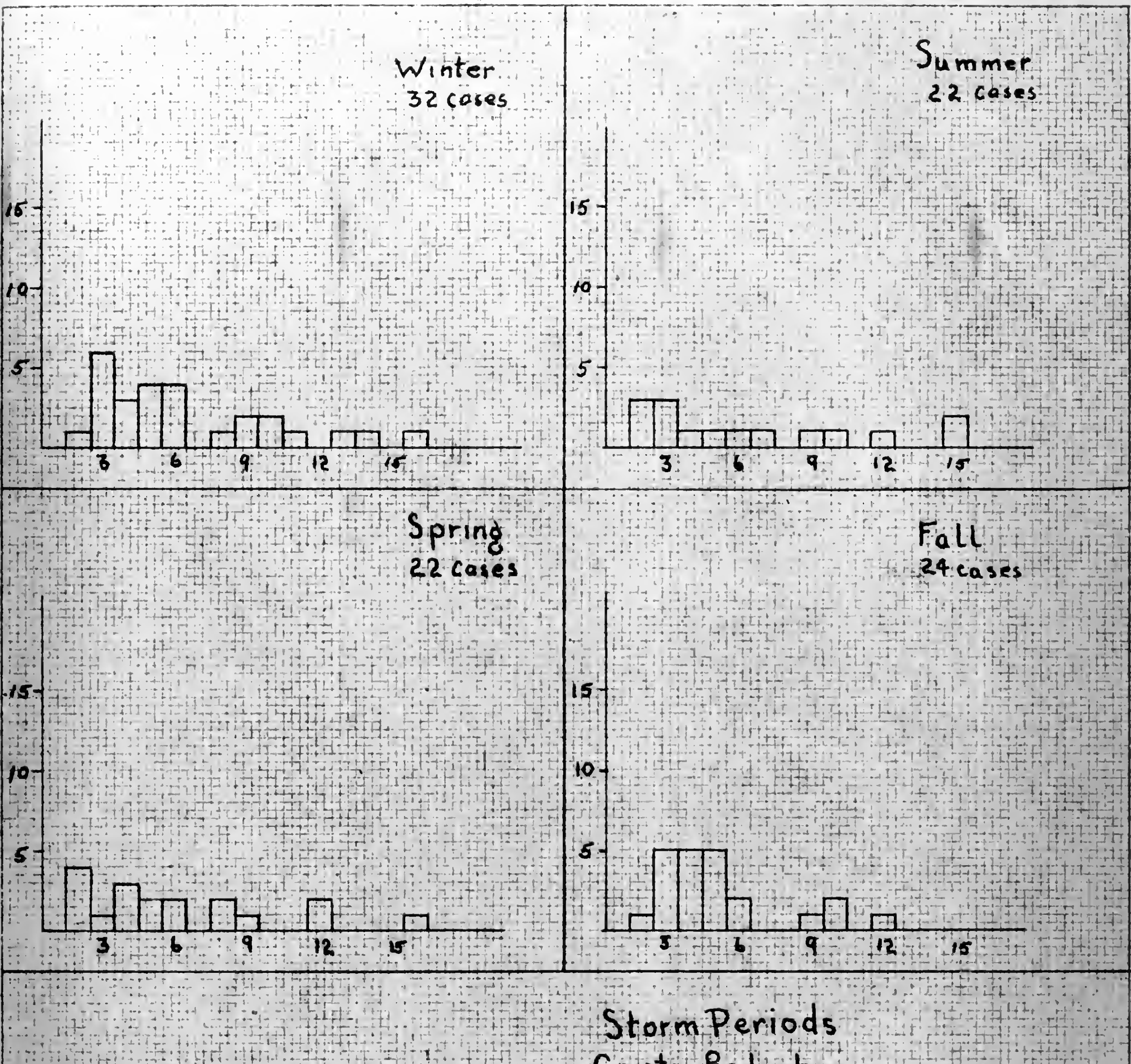
The study was made for the four seasons: winter, summer, spring, and fall, and the total of the three years and nine months. Graphs were drawn for each of the seven stations for the four seasons and totals using the total number of cases against the period in days between the maximum precipitation.

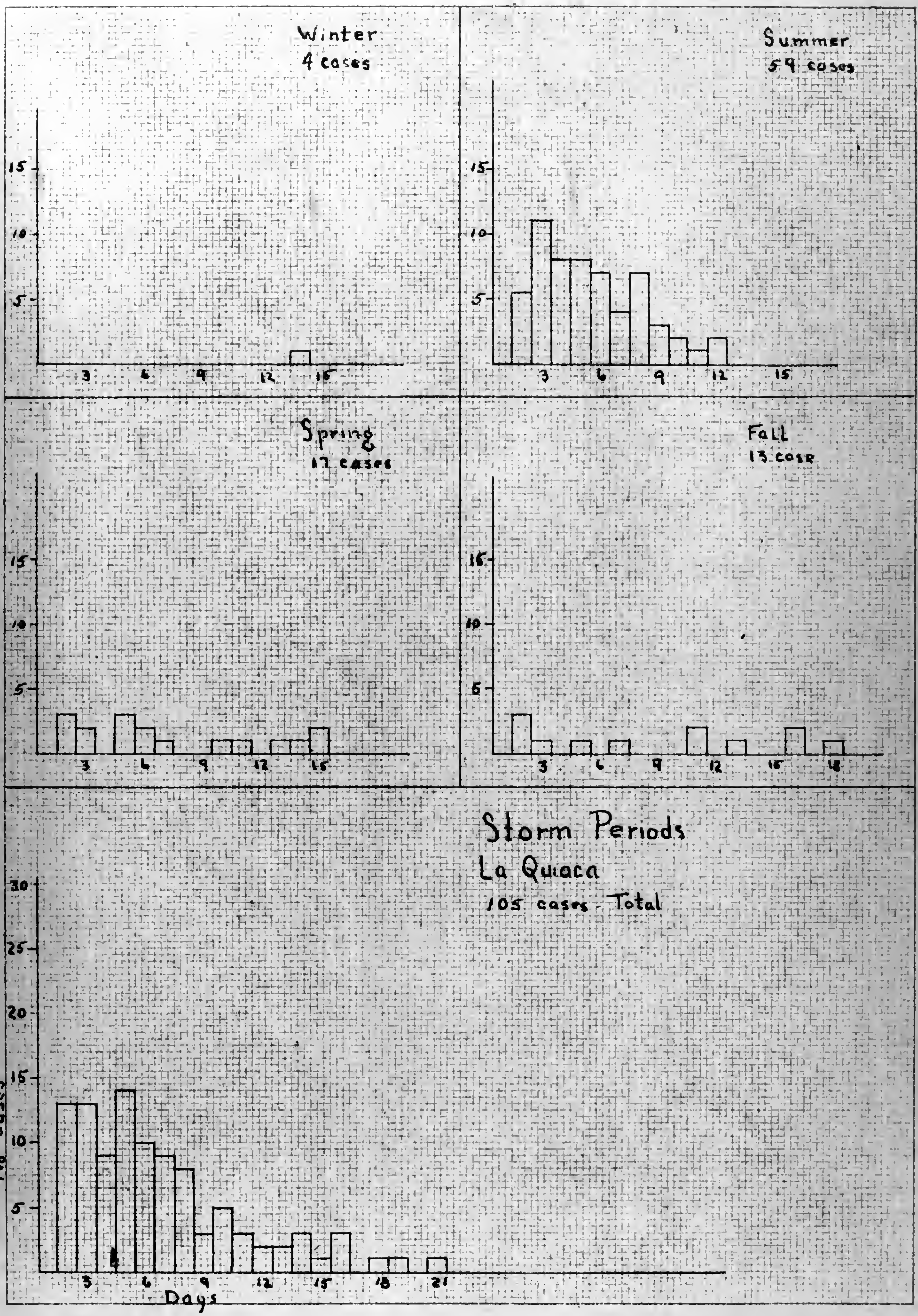
Results of the period between maximum precipitation which shows a maximum at three days led to a second study. This was to determine the percentage of the periods of maximum precipitation that occurred in intervals of three and six days. A second set of graphs were drawn showing the results.

The graphs show a definite peak at the period of three days between maximum precipitation. The percentages in the case of the three day periods were higher than the six day periods. The greater number of cases occurred at Ushuaia, which is at the southern most part of South America. There is no orographic influence at this station as there is in the station to the north.

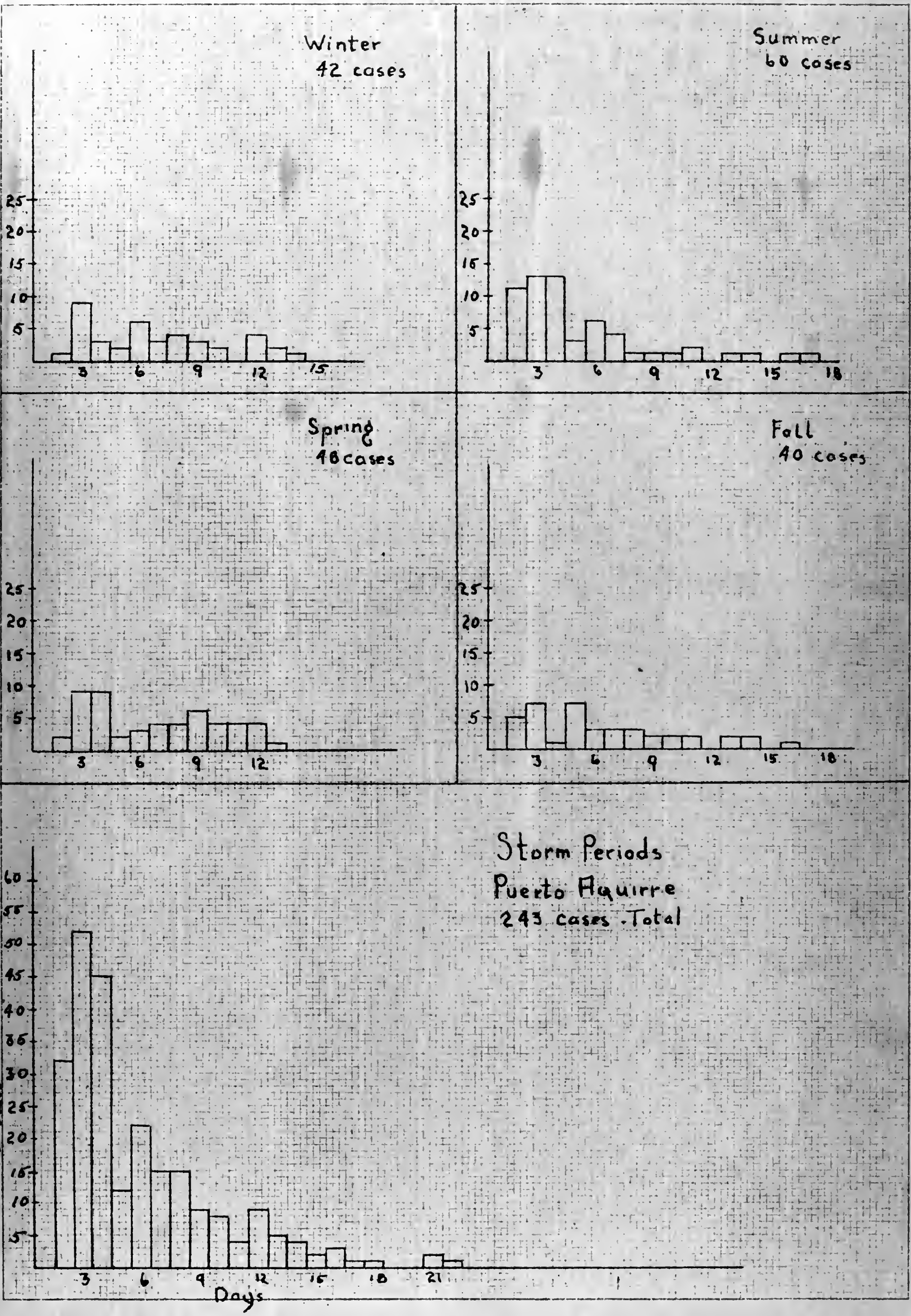
Further study could be made following the work of Robert Elloitt in which he uses only storms in which ten percent of the monthly precipitation fell. This may show a larger interval

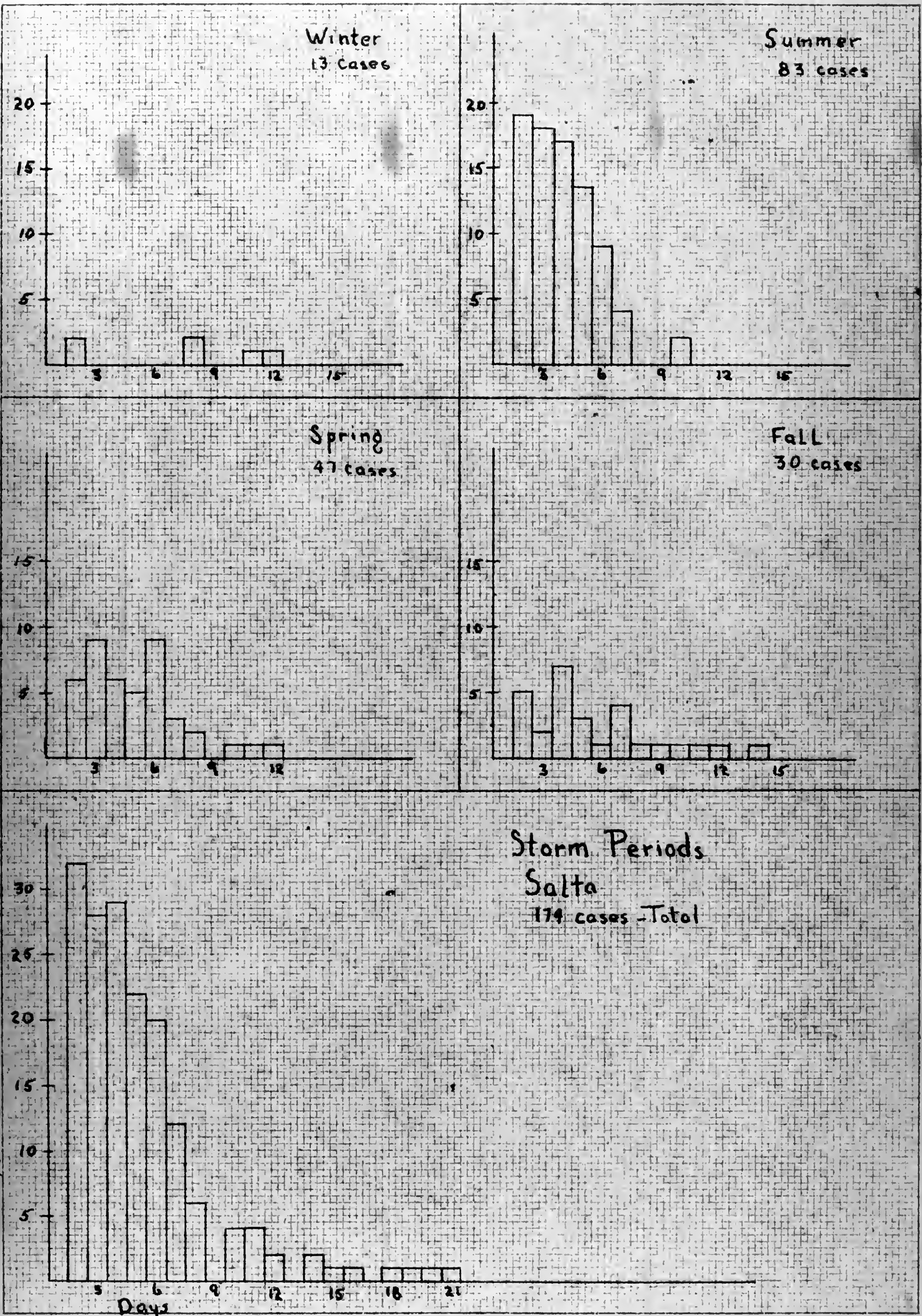
between appreciable storm periods.

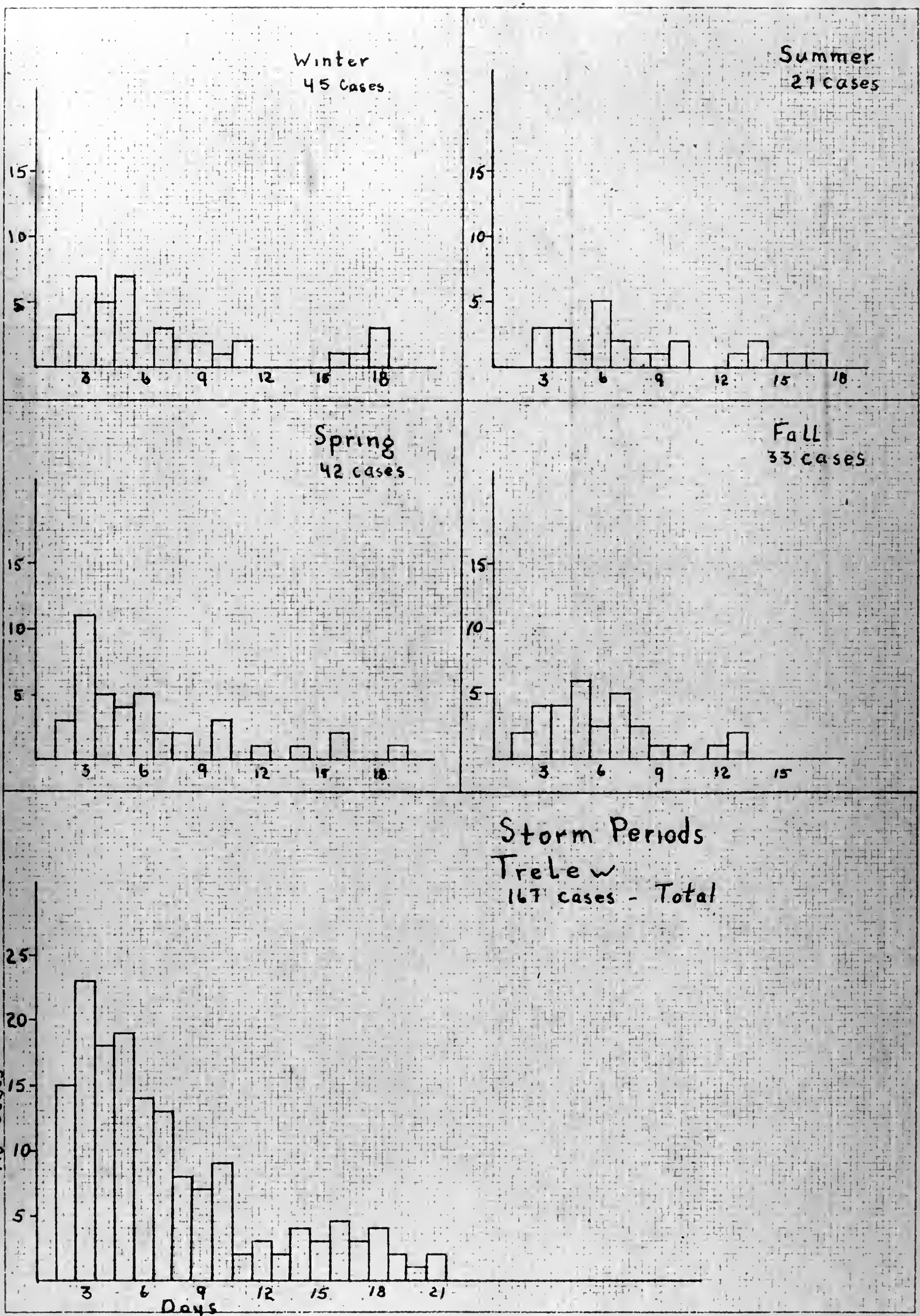

Winter
32 cases
Summer
22 cases
Spring
22 cases
Fall
24 cases
Storm Periods
Cristo Redentor
105 cases - Total
No Cases
Days

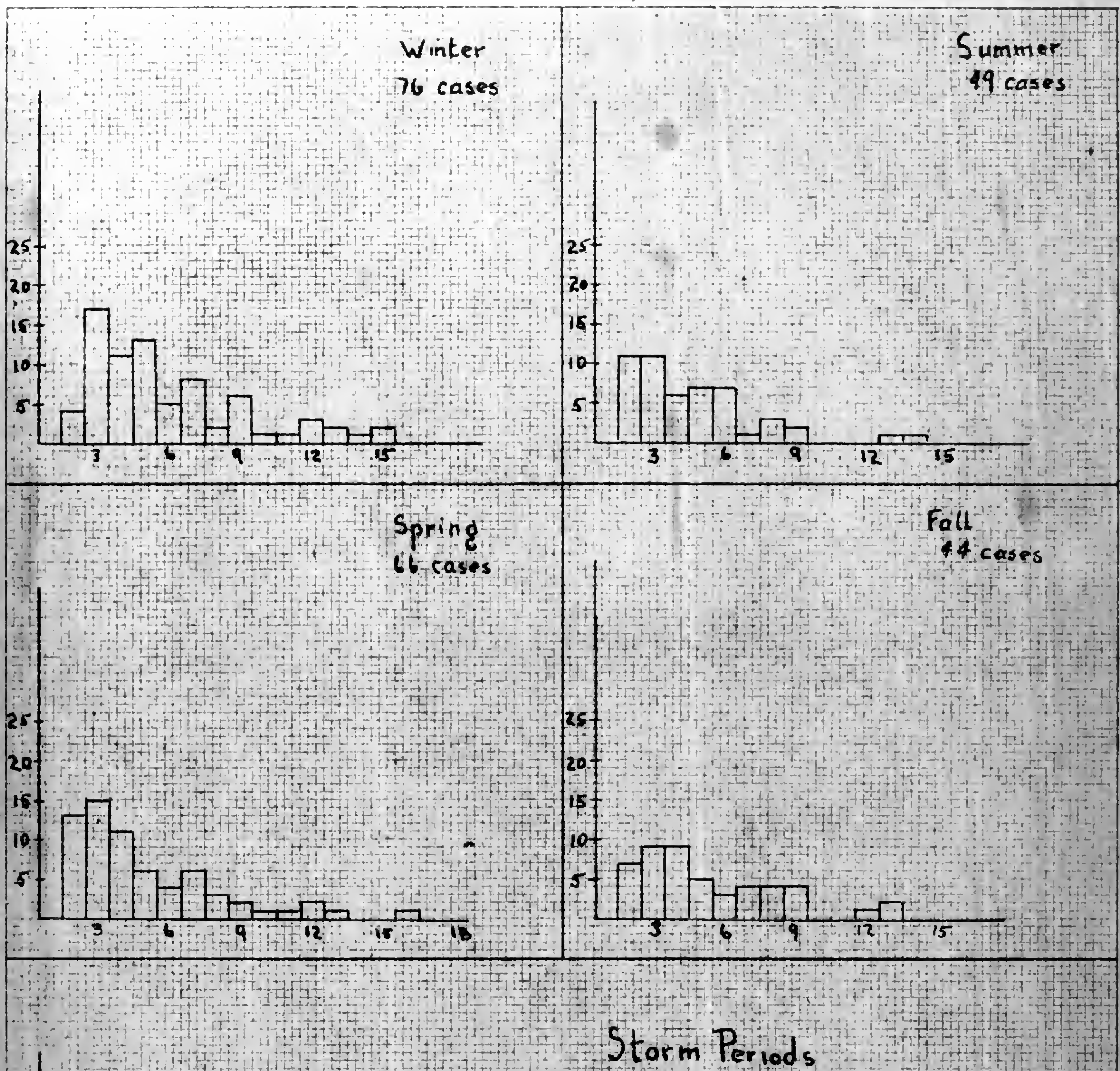


Winter
4 cases
Summer
59 cases
Spring
17 cases
Fall
13 case
Storm Periods
La Quiaca
105 cases - Total
No Cases
Days

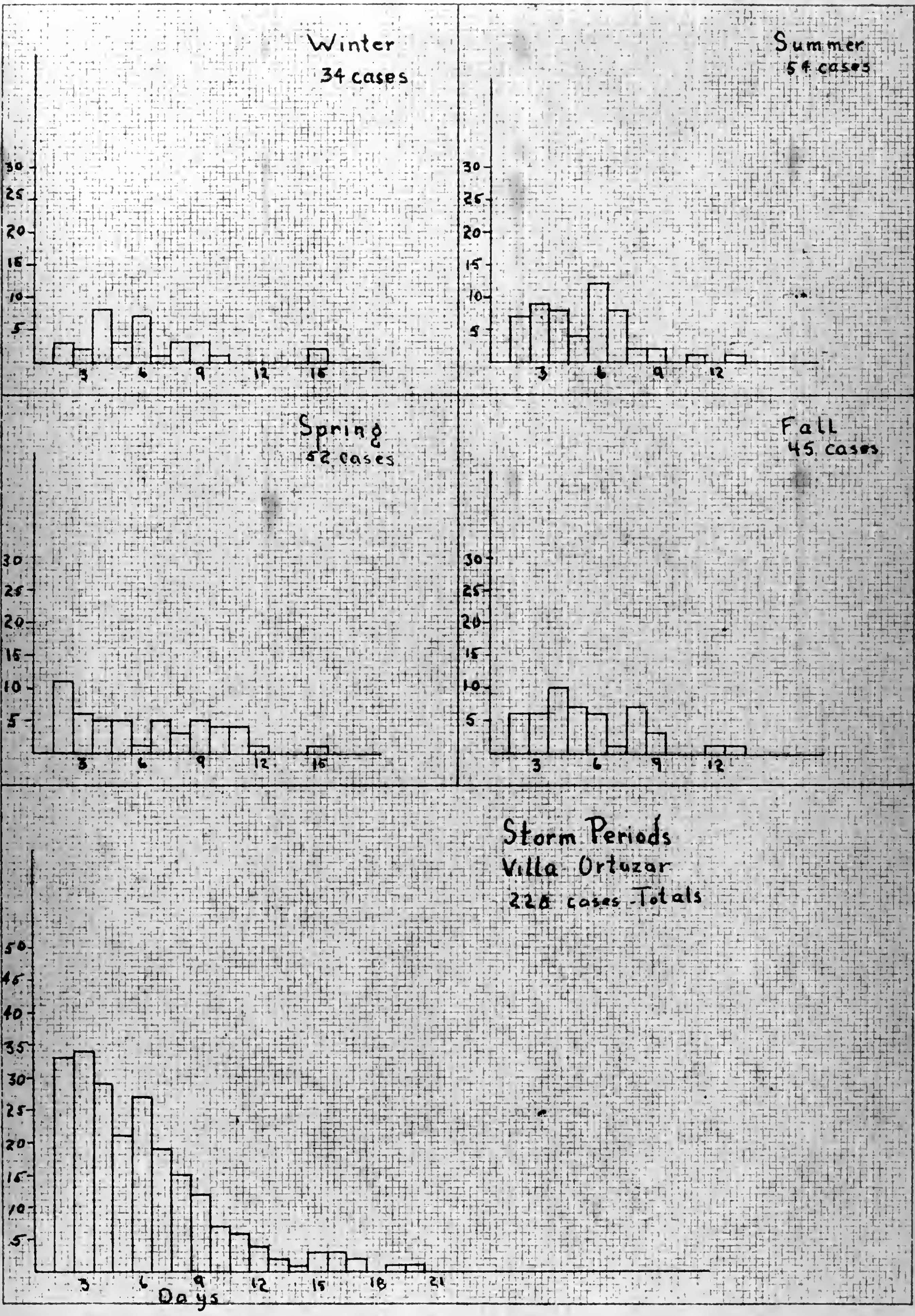

Winter
42 cases
Summer
60 cases
Spring
48 cases
Fall
40 cases
Storm Periods
Puerto Aguirre
243 cases Total
No Cases
Days


Winter
13 cases
Summer
83 cases
Spring
47 cases
Fall
30 cases
Storm Periods
Salta
174 cases - Total
No Cases
Days


Winter
45 Cases
Summer
27 cases
Spring
42 cases
Fall
33 cases
Storm Periods
Trelew
167 cases - Total
No Cases
Days

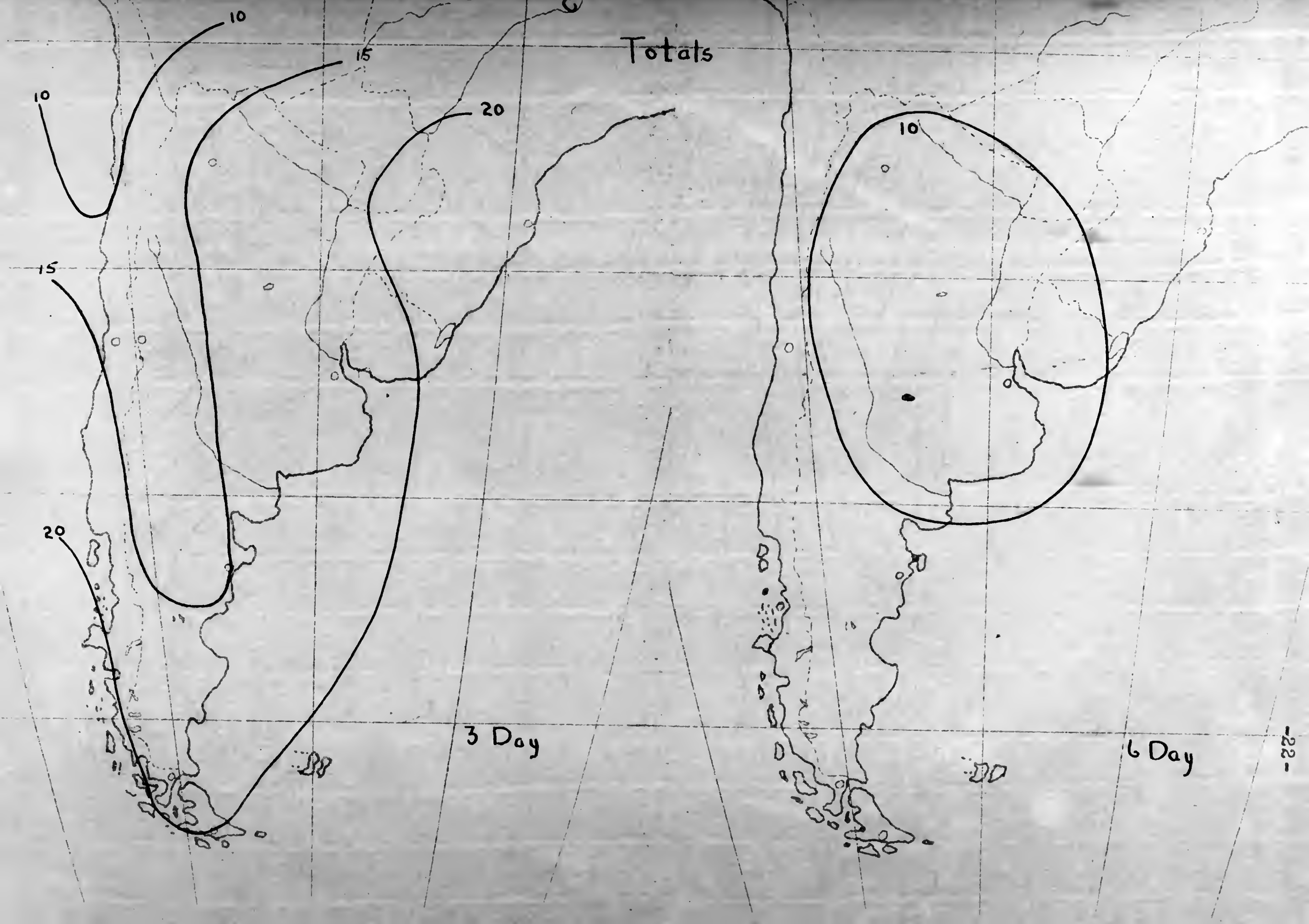


Winter
76 cases
Summer
49 cases
Spring
66 cases
Fall
44 cases
Storm Periods
Ushuaia
268 cases-Total
No. Cases
Days

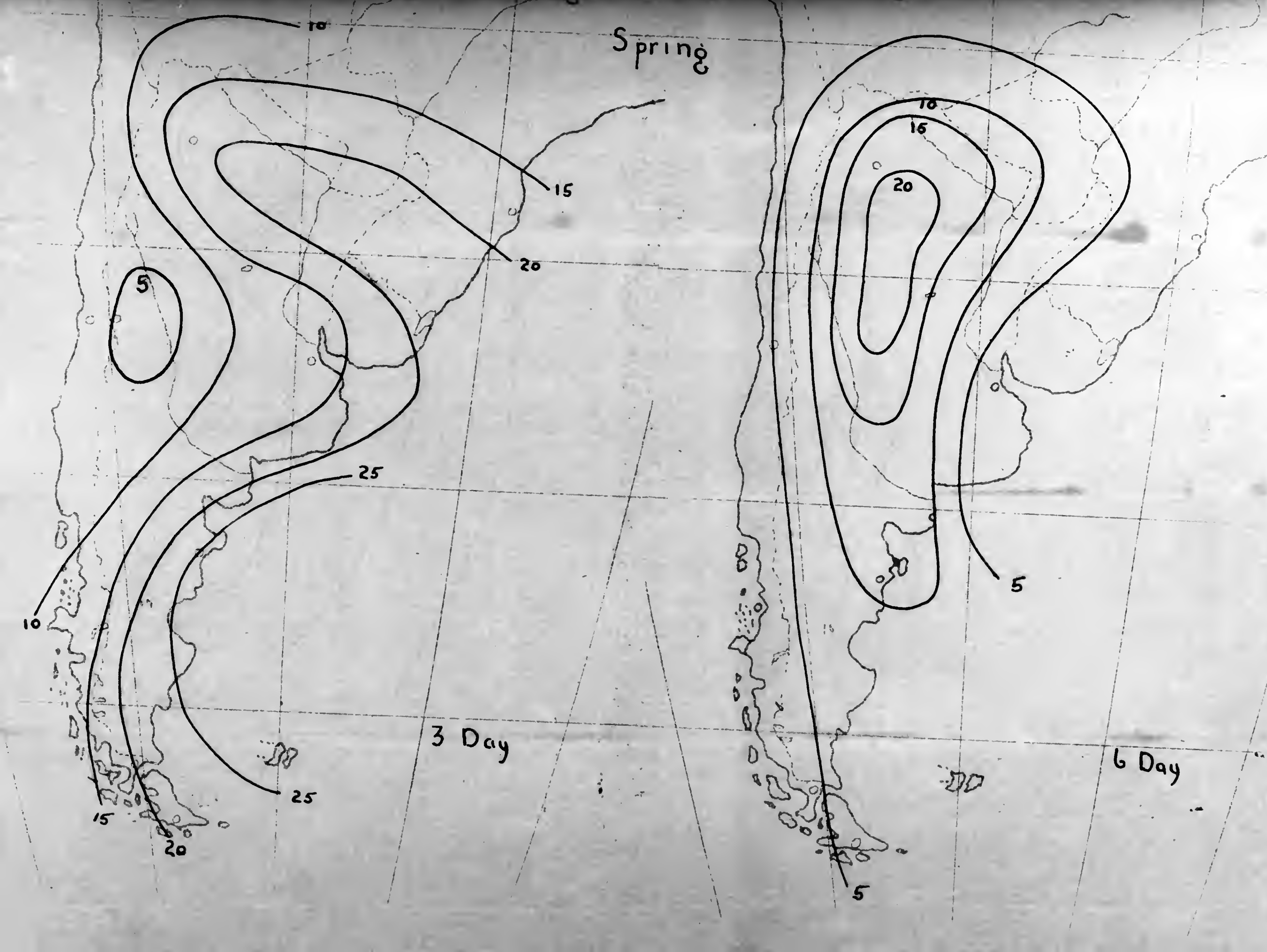

Winter
34 cases
Summer
54 cases
Spring
52 cases
Fall
45 cases
Storm Periods
Villa Ortuzar
228 cases Totals
No. Cases
Days

# Percentage of Storm Periods

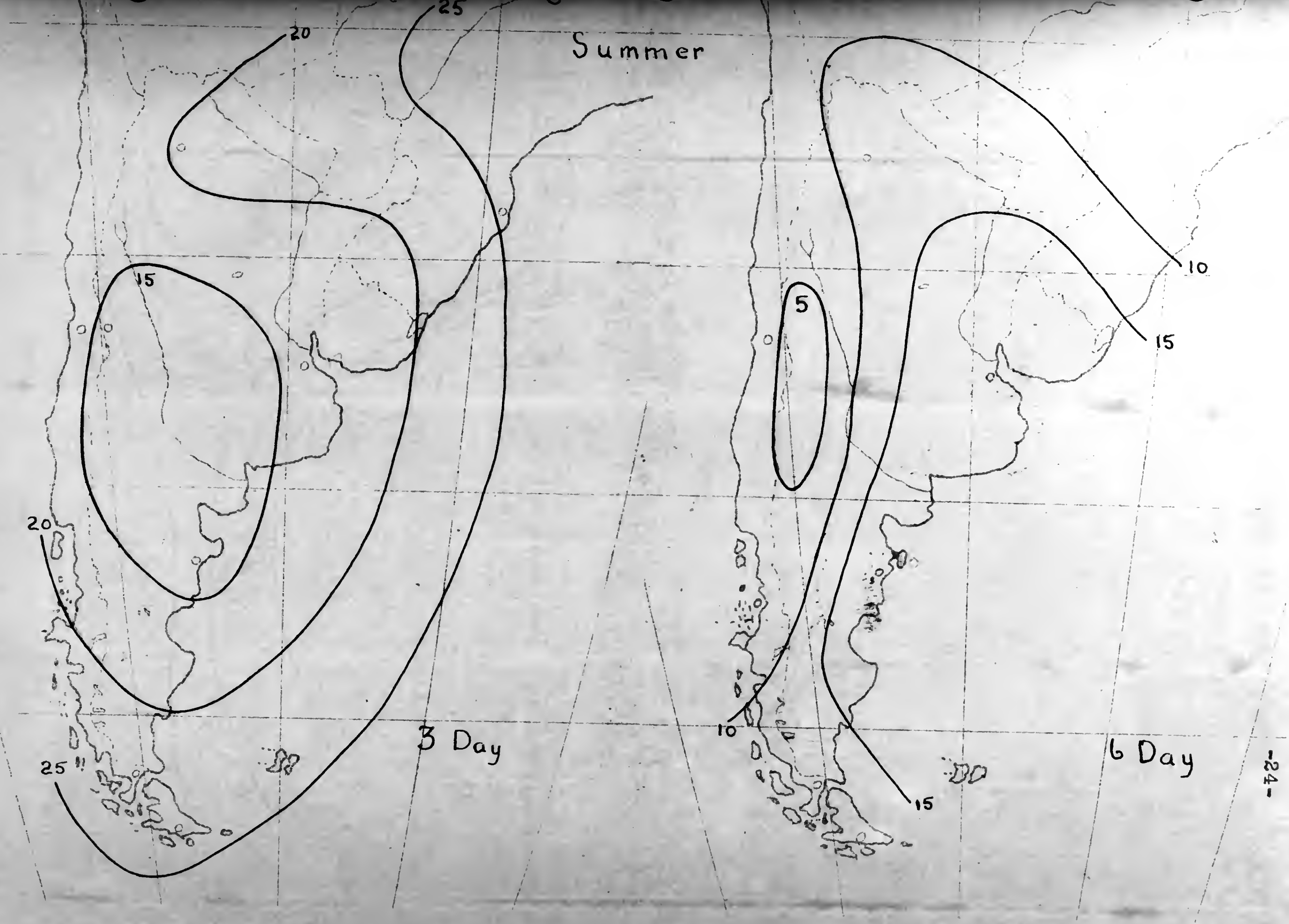
## Totals



... Storm Periods

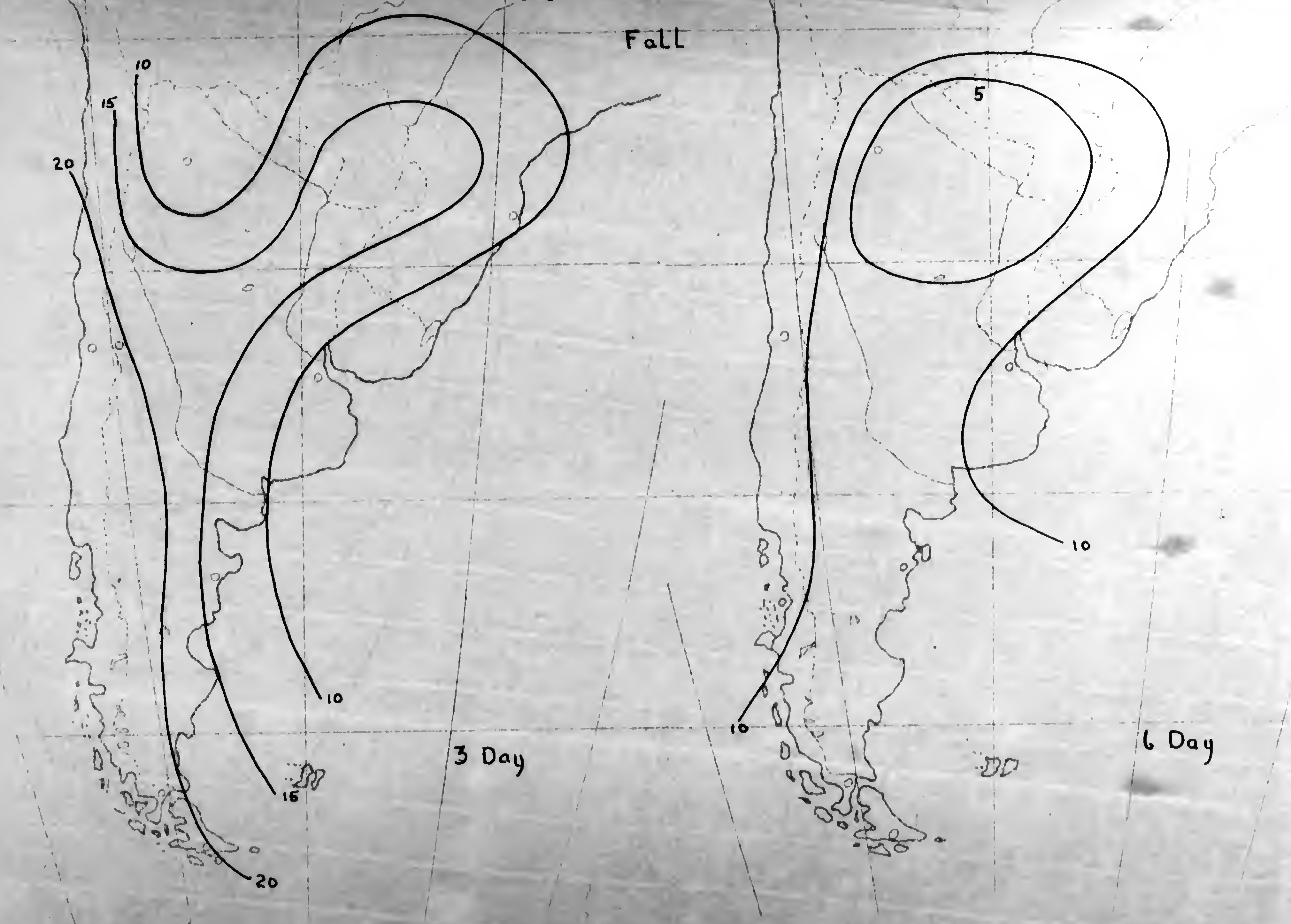


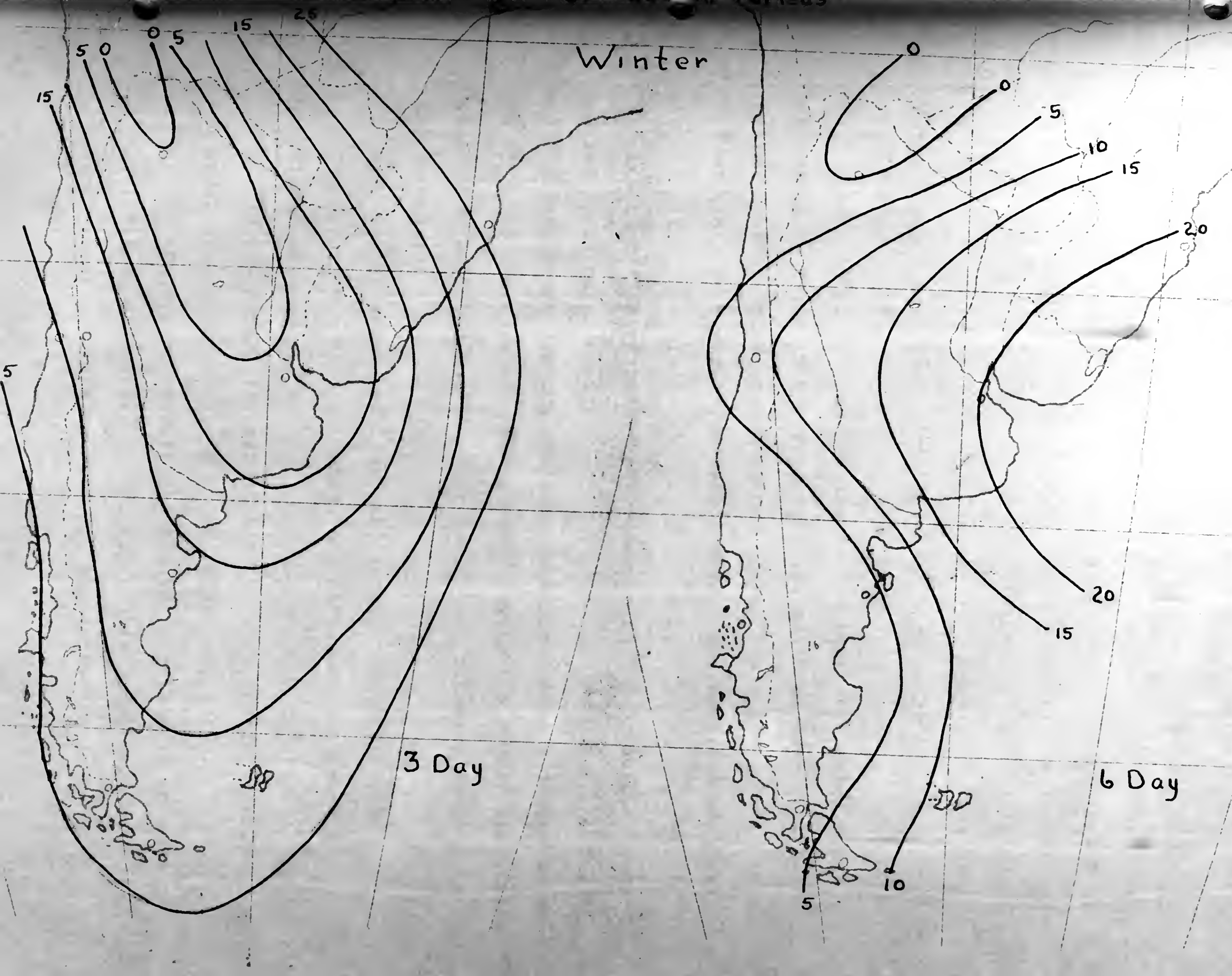
## Percentage of Storm Periods



Percentage of Storm Periods

Fall




Winter
3 Day
6 Day
0
5
10
15
20
25

UPPER AIR STREAMLINE PATTERNS

In the study of the general features of South American weather, it was believed best to select extreme months for the recording of the upper wind patterns. The months chosen were July and January. Data was recorded and North and East components of winds calculated for the months of July 1939, 1940, and 1941, and January 1941. Streamline charts for the months July 1941 and January 1941, were drawn. The calculations were made from data available for eighteen stations covering the Republic of Argentina completely.

The level chosen was the ten hectometer level taken above the station, which is approximately the altitude used in the United States. With most stations it was found possible to take the stations at exactly ten hectometers. The stations with altitudes given, are listed at the end of this discussion. The final streamlines presented were made using the principles summarized by Stone and Weir.

Although the results are well summarized by the charts shown in figure one or two of this section showing the summer and winter upper flow patterns for the year 1941, the following statements may be made:

a. For the summer of 1941, the deformation field has its divergence axis oriented in a northwest southeast alignment.

b. In the winter the orientation is more toward a meridianal alignment and is in a NNW to SSE direction.

c. In the summer picture the center of action is located at latitude 35 degrees south, and longitude 55 degrees west, which is close to the area where the Rio de La

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Pata meets the coast.

In winter the extrapolated center lies to the northwest near the coast at approximately latitude 27 degrees south, and longitude 72 degrees west. The axis lies in a line over Cordoba, Parana, and Buenos Aires.

d. Checking the position of the divergence axis and the center of the deformation field with the total precipitation for both July and January, one finds the following: For summer; Villa Ortuzar, 101 mm. in January when the center of action is directly over the station. For winter; Villa Ortuzar 52mm. in July when the center has shifted northward but when the divergence line reaches over the station.

e. Further it may be noted and more clearly from the Isogone chart, figures 3 and 4, that at this level the winds from the tropical regions move further south. This is best seen by noting that the "O" North Isogone separates positive and negative north components and the positive north components further south, while negative west east which are easterly components are found further south, especially along the coast.

At first glance it may appear that the line along which the winds converge has moved but little from summer to winter. The interpretation given is that the center of the deformation field has moved north west and that the part of the line seen over the land in July is that part which is over the Atlantic and further south in the summer. However, even if this explanation is admitted the line has moved less than 12 degrees latitude.

| STATION | LEVEL IN HECTOMETERS |
|---|---|
| Capital Federal | 10 |
| Mercedes | 18 |
| Junin | 10 |
| Cristo Redentor | 46 |
| Rosario | 10 |
| Parana | 10 |
| Cordoba | 15 |
| Corrientes | 10 |
| Azul | 10 |
| Harding Green | 10 |
| San Antonio Oeste | 10 |
| Bariloche | 10 |
| Trelew | 10 |
| Commodoro Rivadavia | 10 |
| San Julian | 10 |
| Rio Gallegos | 10 |

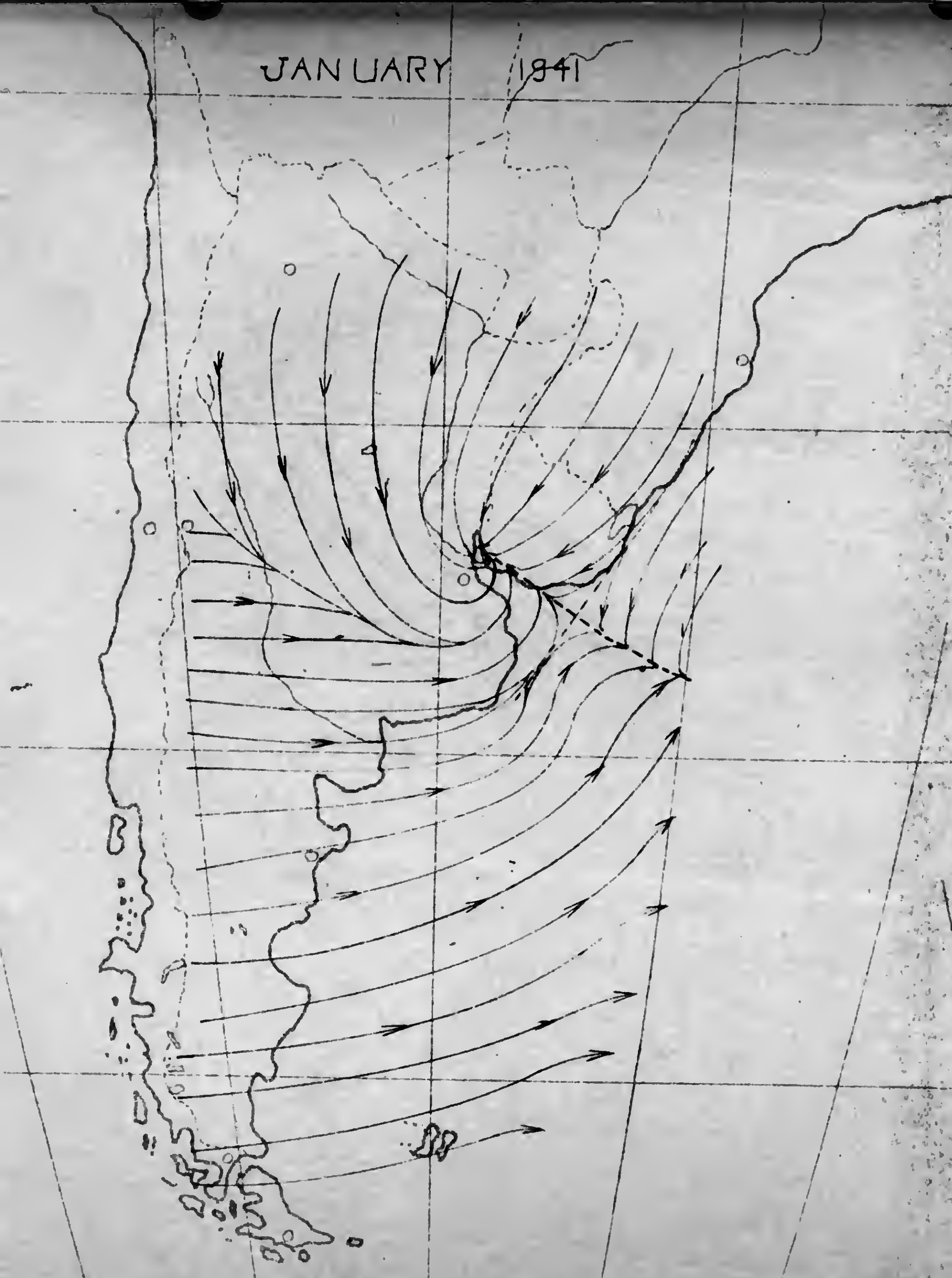



Fig. 1: SUMMER

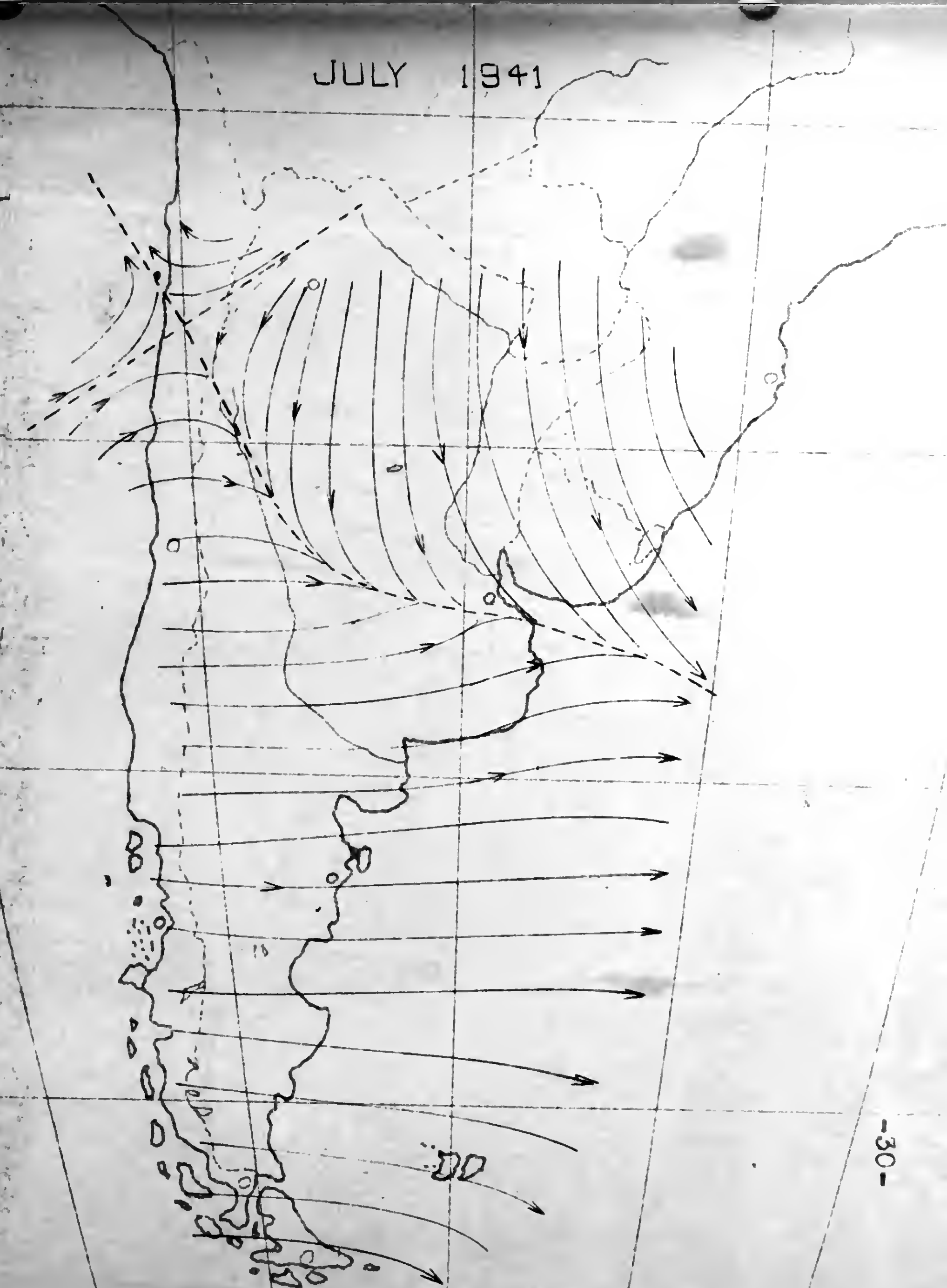



Fig. 2: WINTER

# ISOGONES

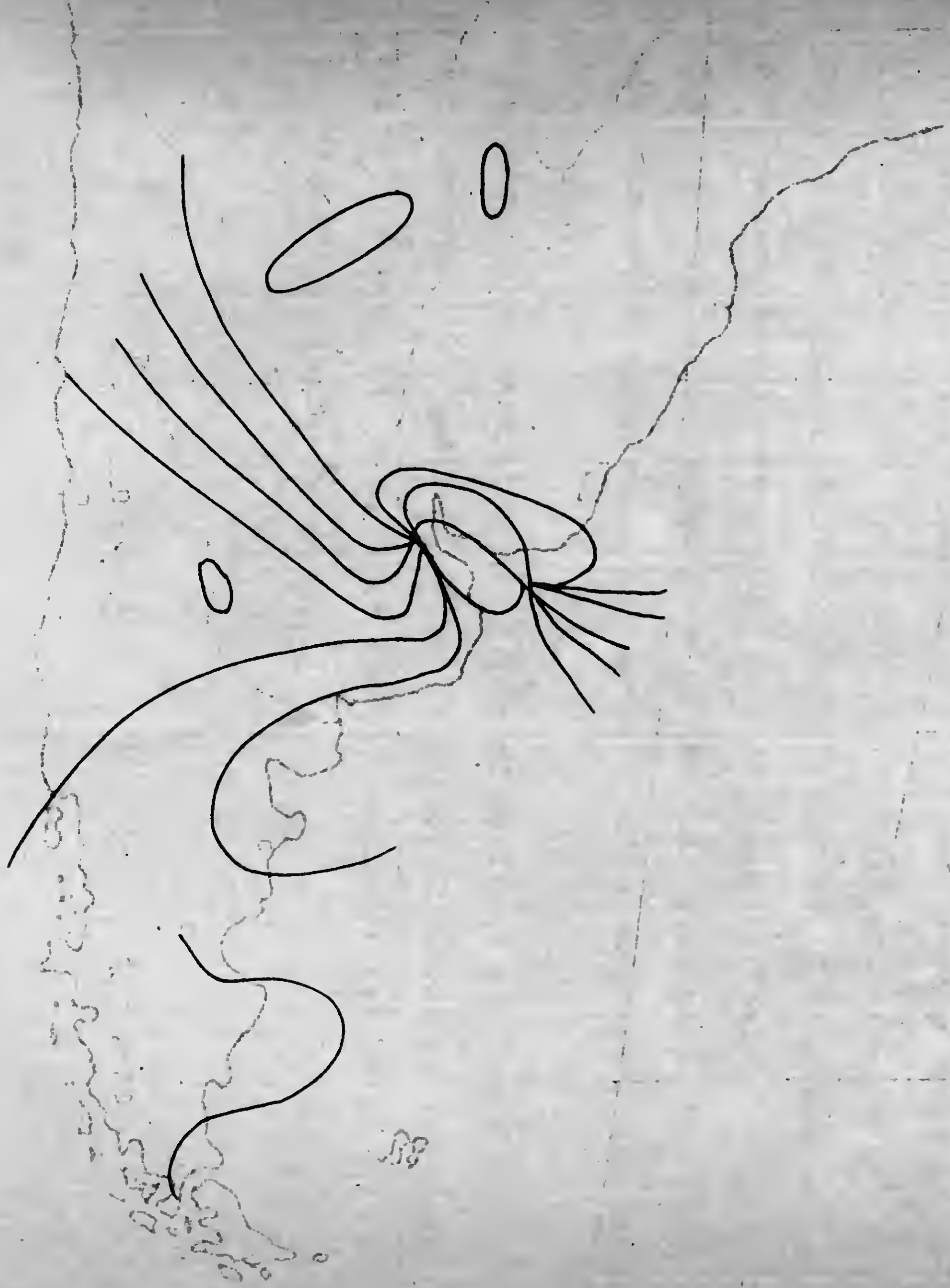


Fig. 3: SUMMER

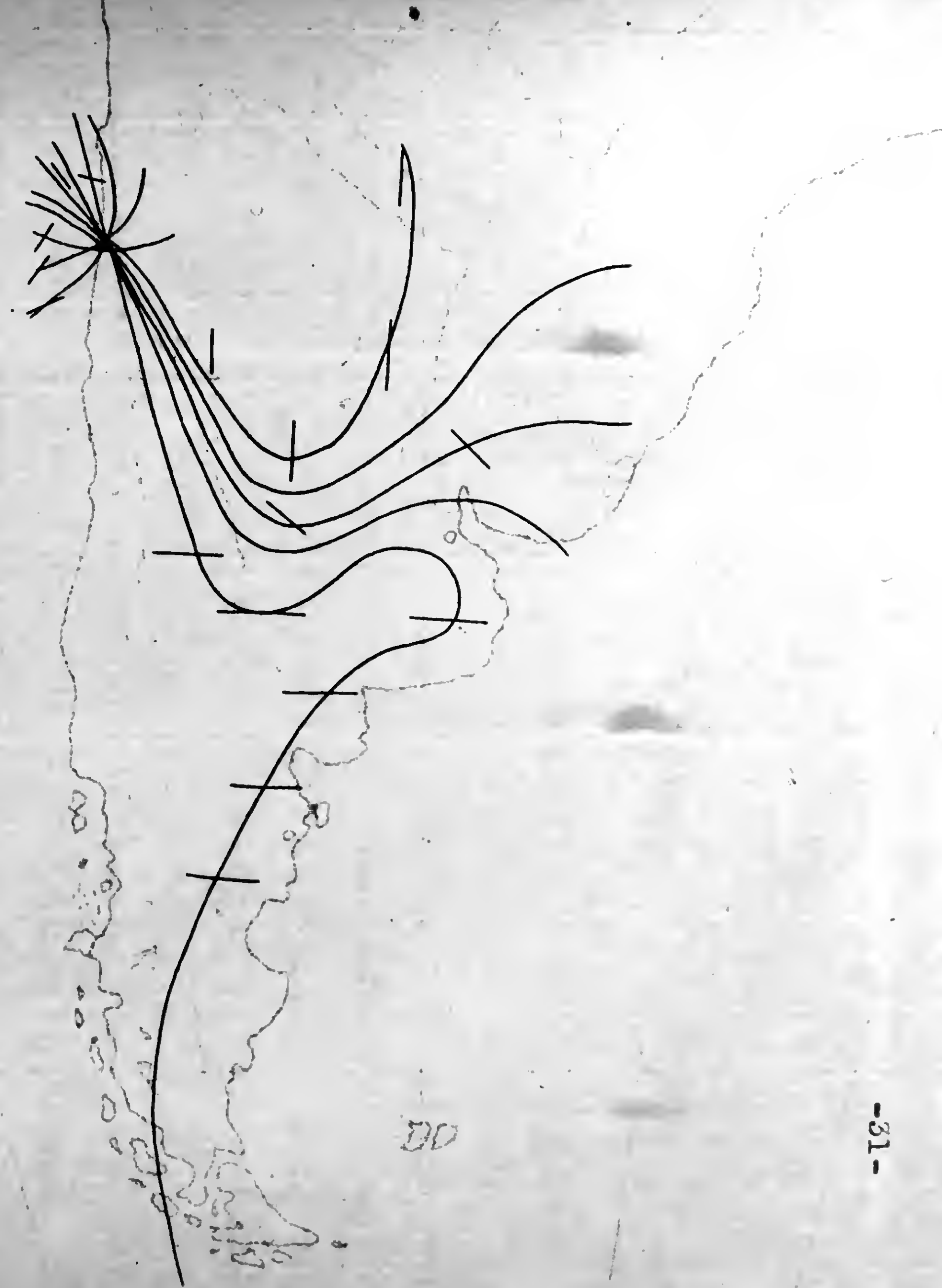


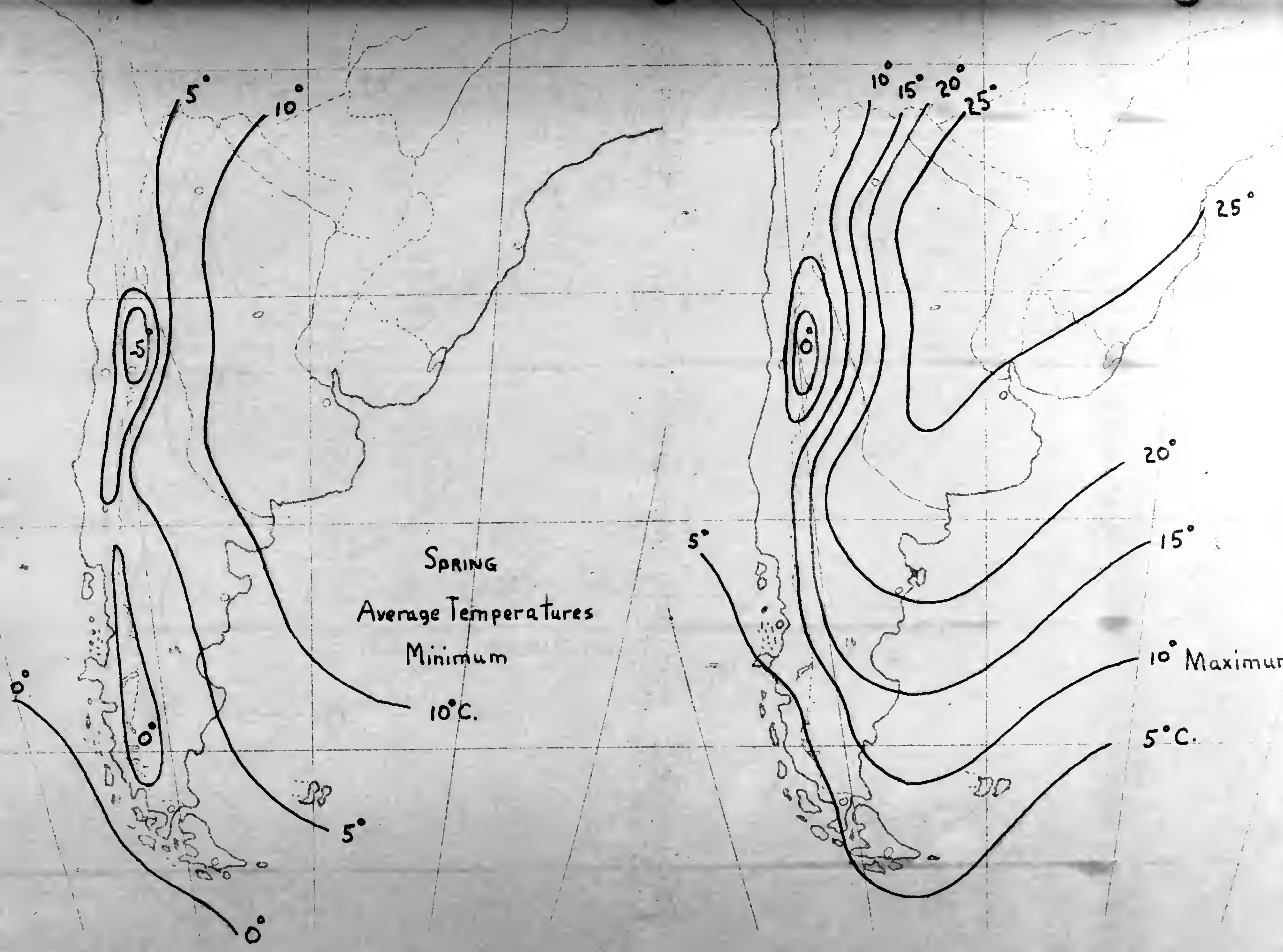
Fig.4: WINTER

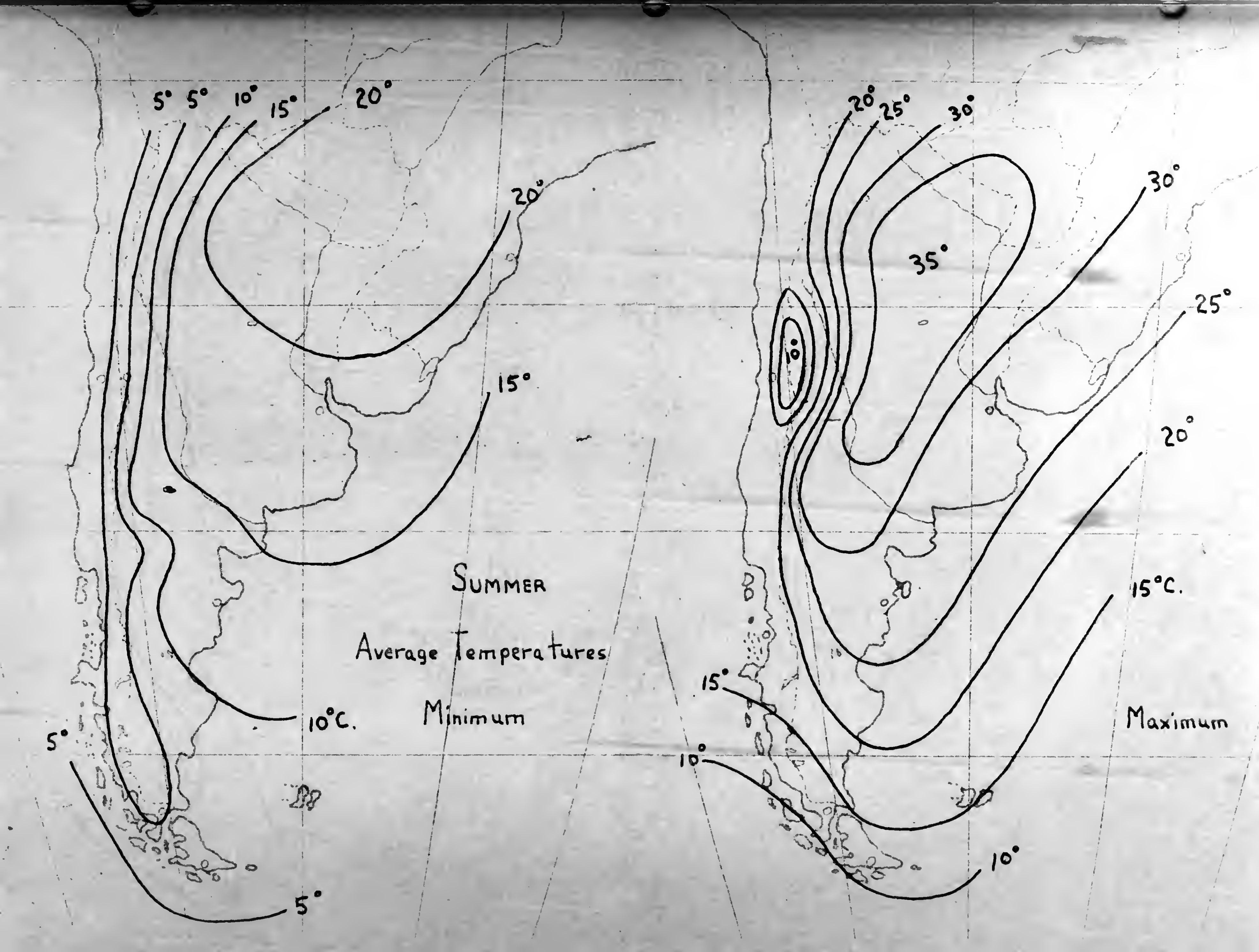
TEMPERATURE

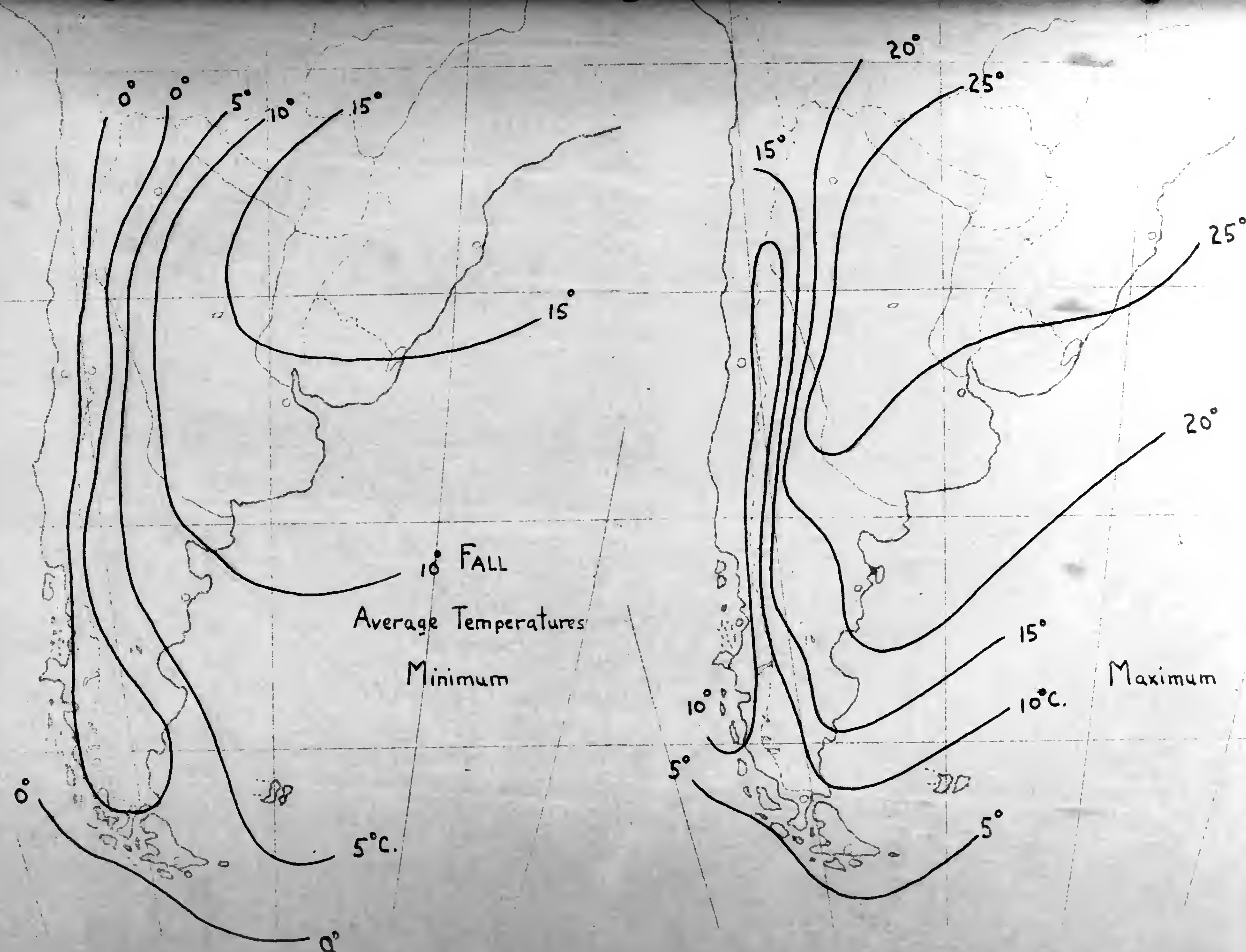
Temperature charts have been drawn for daily average minimum and average maximum temperatures which might be expected for the four seasons. Summer was defined as December, January, and February; fall as March, April, and May; winter as June, July, and August; and spring as September, October, and November. The average temperatures were not computed exactly since a difference of a degree or two in the value at any particular station could not change the shape of the curves by an appreciable amount. The curves were not extended beyond Argentina since the data available covered only that country.

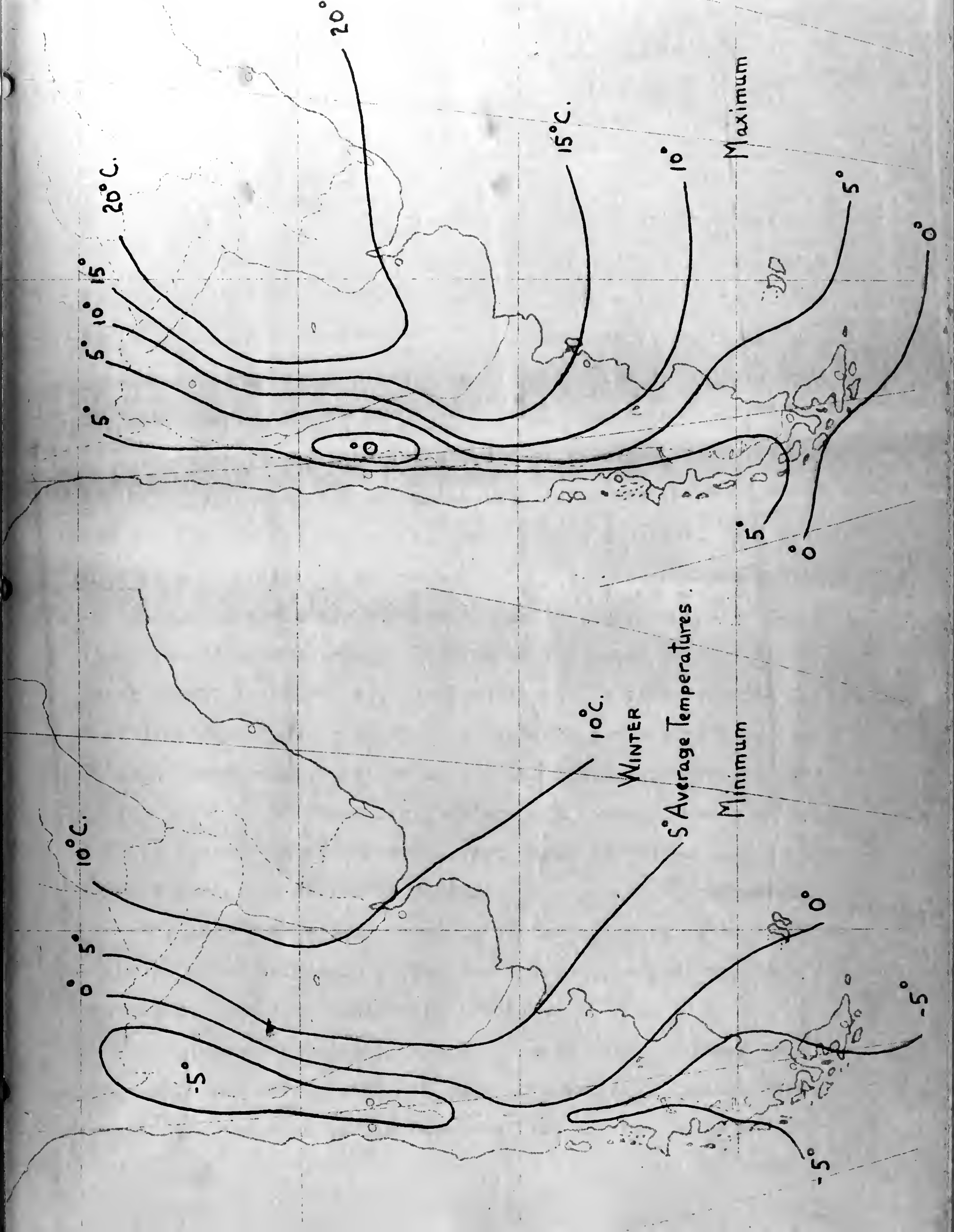
As would be expected, the isolines parallel the high mountains on the west side of Argentina. Temperature values along the mountains are representative only of mountain passes. On the east side of the mountains at altitudes of four thousand to five thousand feet are found the highest temperature changes. This is especially true at latitudes of 35 to 40 degrees. In this region, the clearing influence of the air flowing downslope from the high passes combines with the thin air due to the high altitude to give large diurnal ranges, often as great as 30 degrees centigrade.

Along the coast, the influence of maritime air keeps the temperature more constant. This is especially true at the southern tip of the continent where continued cloudiness helps to keep the temperature more constant.


Spring
Average Temperatures
Minimum
10°C.
10°
5°
-5
0°
0°
5°
0°
0°
Maximum
10°
15°
20°
25°
25°
20°
15°
10° Maximum
5°C.
0
5°


Summer
Average Temperatures
Minimum
Maximum
5°
5°
10°
15°
20°
20°
15°
10°C.
5°
5°
20°
25°
30°
35°
10°
30°
25°
20°
15°C.
15°
10°
10°


10° FALL
Average Temperatures
Minimum
Maximum
0°
0°
5°
10°
15°
15°
5°C.
0°
0°
20°
25°
15°
25°
20°
15°
10°C.
10°
5°
5°


Maximum
20°C.
20°
15°C.
10°
5°
0°
Winter
Average Temperatures.
Minimum
10°C.
-5°

TYPE SEQUENCES

A primary goal of this thesis has been to investigate the possibility of establishing weather type sequences for South America, which might be used for classifying past data and forecasting weather in the future.

Papers by Dr. Irving Krick and Robert Elliott give the establishment and method of classification of these type sequences for the North American area. They involve a shift in the isobaric pattern governing the weather of the entire North American continent. This shift has different periodicities superimposed on each other.

In order to measure such a shift in the isobaric field, some center of pressure must be available. In the Northern hemisphere, the Pacific anticyclone may be used as such a center. The existence of such a cell in the South Pacific is unquestioned but it is impossible to locate because of lack of ship reports. There is a semi-permanent trough existing on the coast side of the Andes but it is seldom a closed center and is usually quite flat. Of the migratory centers, the low pressure areas move into the Chilean coast only occasionally and otherwise, the centers move to the south of the Magellan Straits. On a great number of maps the low pressure areas were not even drawn as closed centers and so were worthless as far as determining any shift is concerned.

The last possibility seems to be the characteristic high pressure which builds up across the Andes mountains, breaks off and moves north east toward the tropics.

The Andes mountains have their lowest points between latitudes 41 and 46 degrees. At these latitudes the passes are about five thousand to six thousand feet and the peaks at

about eight thousand feet. To the south, the peaks increase to ten thousand feet and to the north the peaks rise to fourteen thousand feet with the passes at about ten thousand feet, the peaks continue to rise in elevation farther to the north.

It might be expected that there would be a preference for the high pressure to build across the mountains in the latitudes 41 to 46 degrees since the cold air could get across the mountains more easily. A study of three years and nine months of data from January 1938 through September 1941 is shown on the accompanying chart and shows a peak at 37 degrees, another peak at 42 degrees, and a smaller peak around 50 degrees. These were considered as the most important peaks. On the basis of this chart, it was decided, as a first attempt, to divide the cases into three ranges: less than 41 degrees, 41 to 47 degrees, and greater than 47 degrees. In the study of the individual cases for the four years the path of each migratory high was tabulated since in the future, the possibility of further reclassification according to path, as well as the latitude where the high built up across the mountains, might arise.

If the point of high pressure crossing the mountains indicates a shift in the isobaric field, it should be possible to correlate the weather on the east side of the mountains with the latitude of the high crossing the mountains. Unfortunately, time permitted only a partial correlation of temperature and precipitation at certain Argentine stations.

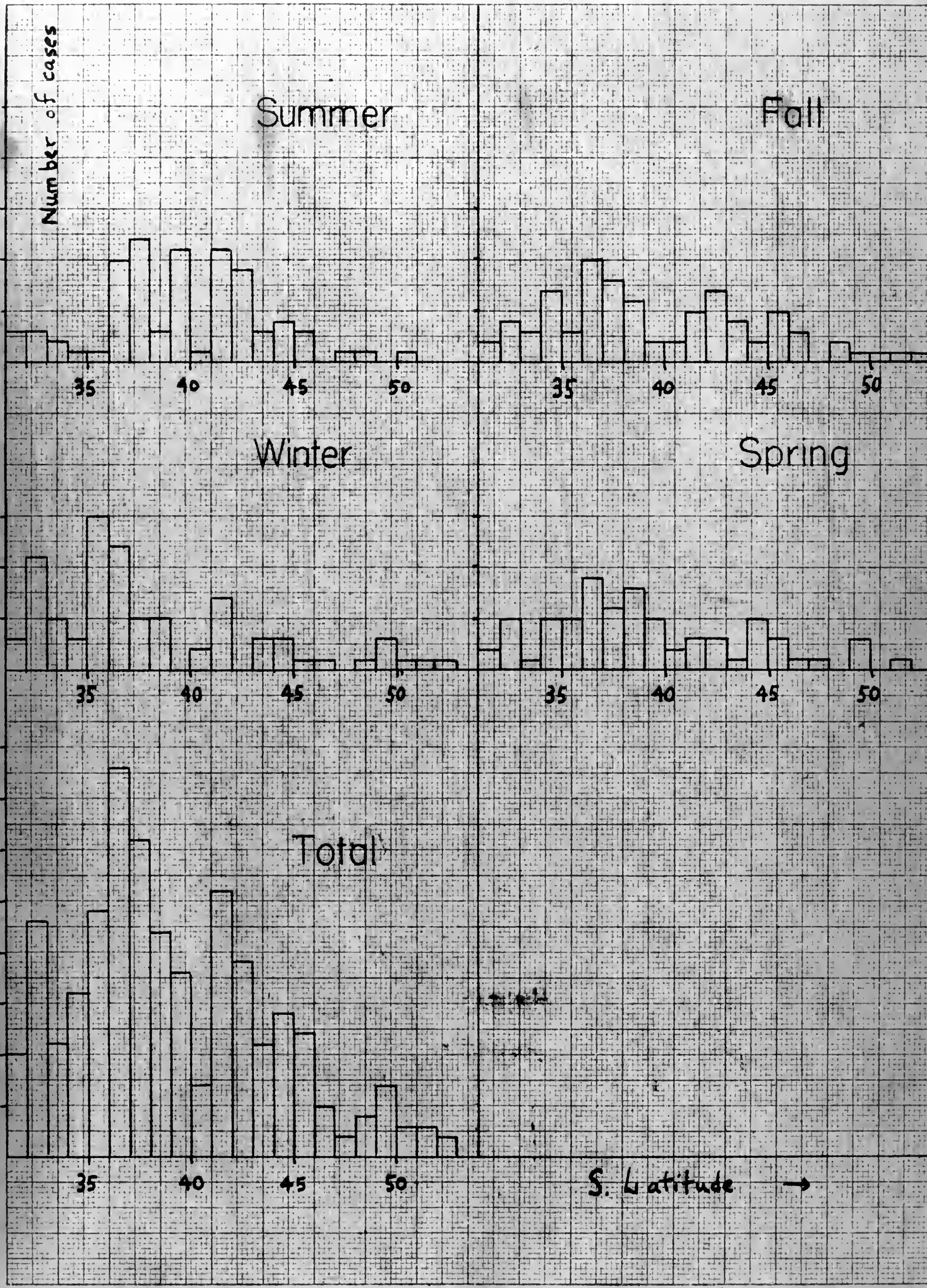
The method used for temperature correlation was by noting temperature changes for each individual high as it becomes a closed center on the east side of the mountains and moves off to the north or north east. By noting the wind shift at the particular station, the time of the cold front passage could be seen.

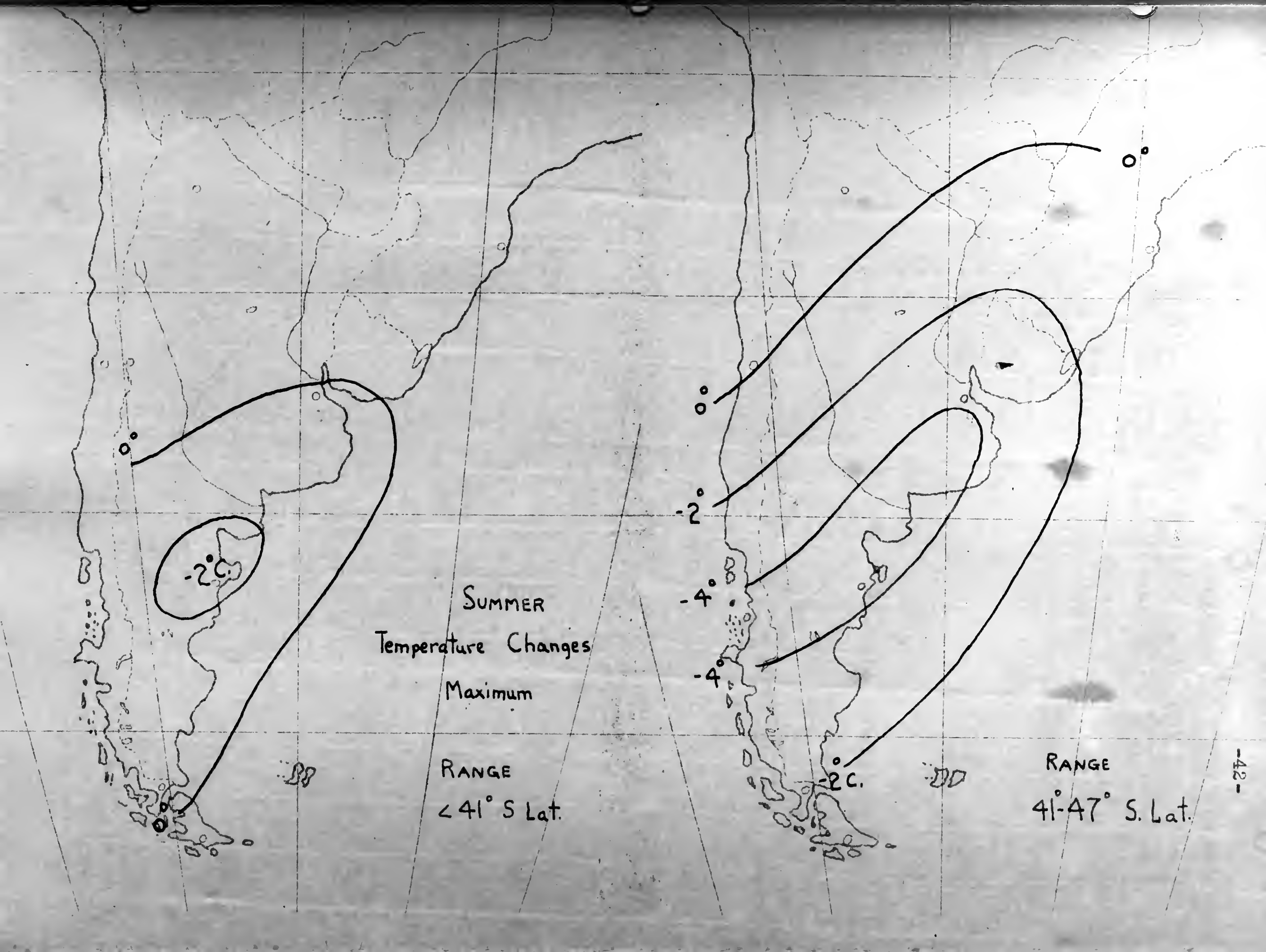
Comparing the average maximum and average minimum temperatures for the two days preceding the cold front passage with those of the two days after, gave an indication of the temperature change for maximum and minimum for each particular high. This was done for only one year, 1938, and for three stations. The temperature change caused by any particular high pressure area is influenced to a great extent by the temperature of the air previously at the station before the outbreak. Also differences in cloud cover and rainfall affect the temperature changes but these last effects, it is hoped, should depend somewhat on the latitude of the original outbreaks. In the charts shown, the ranges, less than 41 degrees and 41 to 47 degrees have been compared. The changes seem to be somewhat greater for the 41 to 47 degree range especially for the maximum temperatures. The small change in maximum temperatures in the range less than 41 degrees may possibly be a result of clearer skies than those resulting from outbreaks in the range 41 to 47 degrees. There were cases, for example, in the less than 41 degrees range, for which the temperature fell more than the average for the 41 to 47 degree range. Also some cases of the 41 to 47 degree range actually had temperature rises greater than many of the less than 41 degree cases. This may be due to the type of air existing at the station preceding the outbreak as noted above, and it is hoped that the average for a year compensates for these differences. The temperature change charts given here should be taken to mean only average changes and the values as approximate ones since the data computed to this time is insufficient to draw accurate charts.

Precipitation was correlated by considering each storm period for five stations in Argentina and determining which type of outbreak was associated with that storm or which type of outbreak

followed immediately after the particular storm. The percentage of cases of any particular range with which any rain was associated were then computed and isolines drawn on the charts. The precipitation is also affected by the type of air at the station prior to the outbreak but the effect should not be as large as for temperature changes.

So before, only the two northern ranges were compared since the majority of cases fell into one of those two ranges. At some stations, the rainfall correlated quite well with the latitude of the outbreaks. At Puerto Aquirre, the farthest north station considered, for certain seasons of the year, the rain was almost entirely associated with the range less than 41 degrees. Buenos Aires seemed to be in the band which received rain from both types so that the difference was small between the two ranges. However, a further study of amounts might lead to a differentiation between the two ranges.

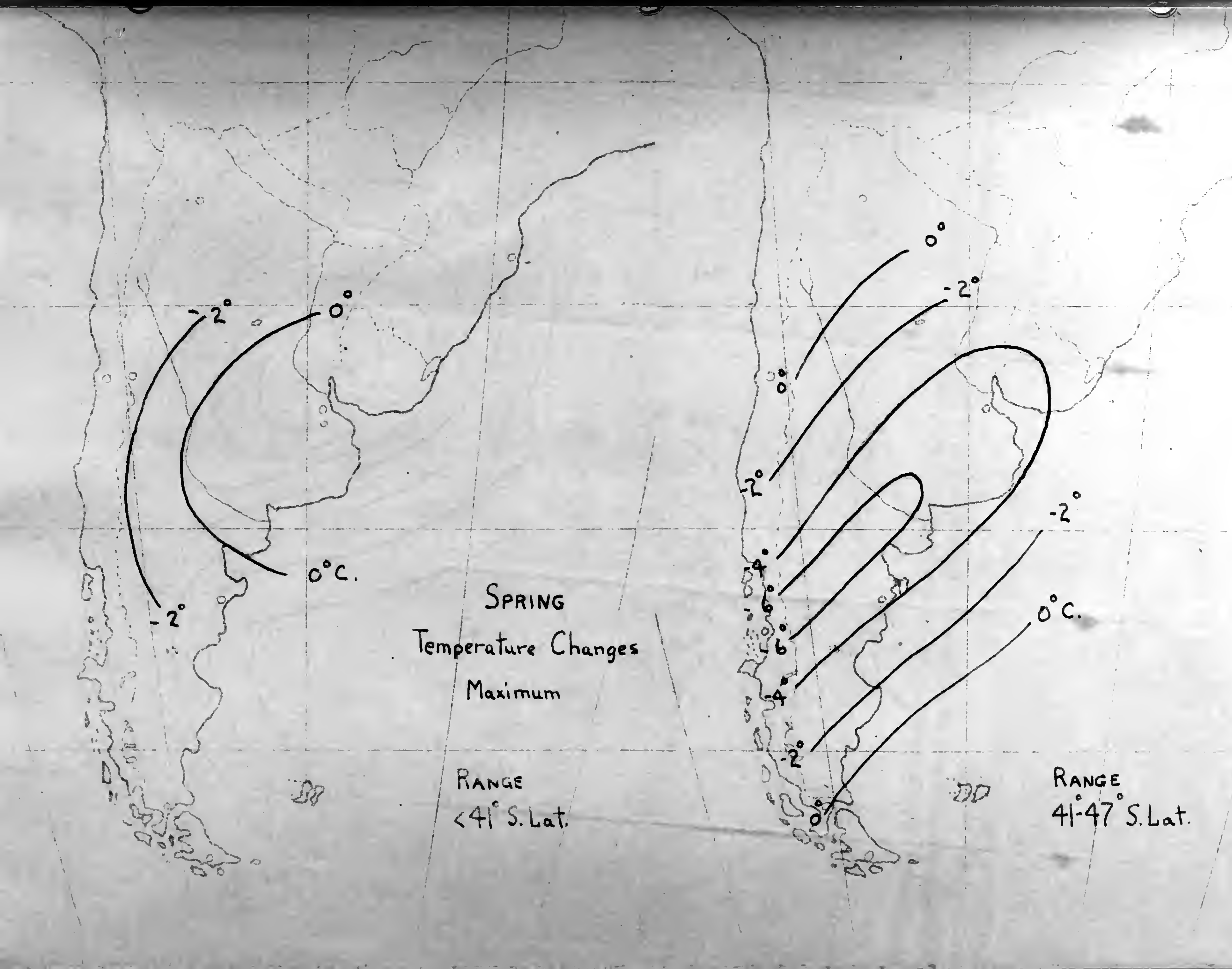

Number of cases
Summer
Fall
Winter
Spring
Total
S. Latitude →
0
5
10
15
20
25
30
35
40
35
40
45
50

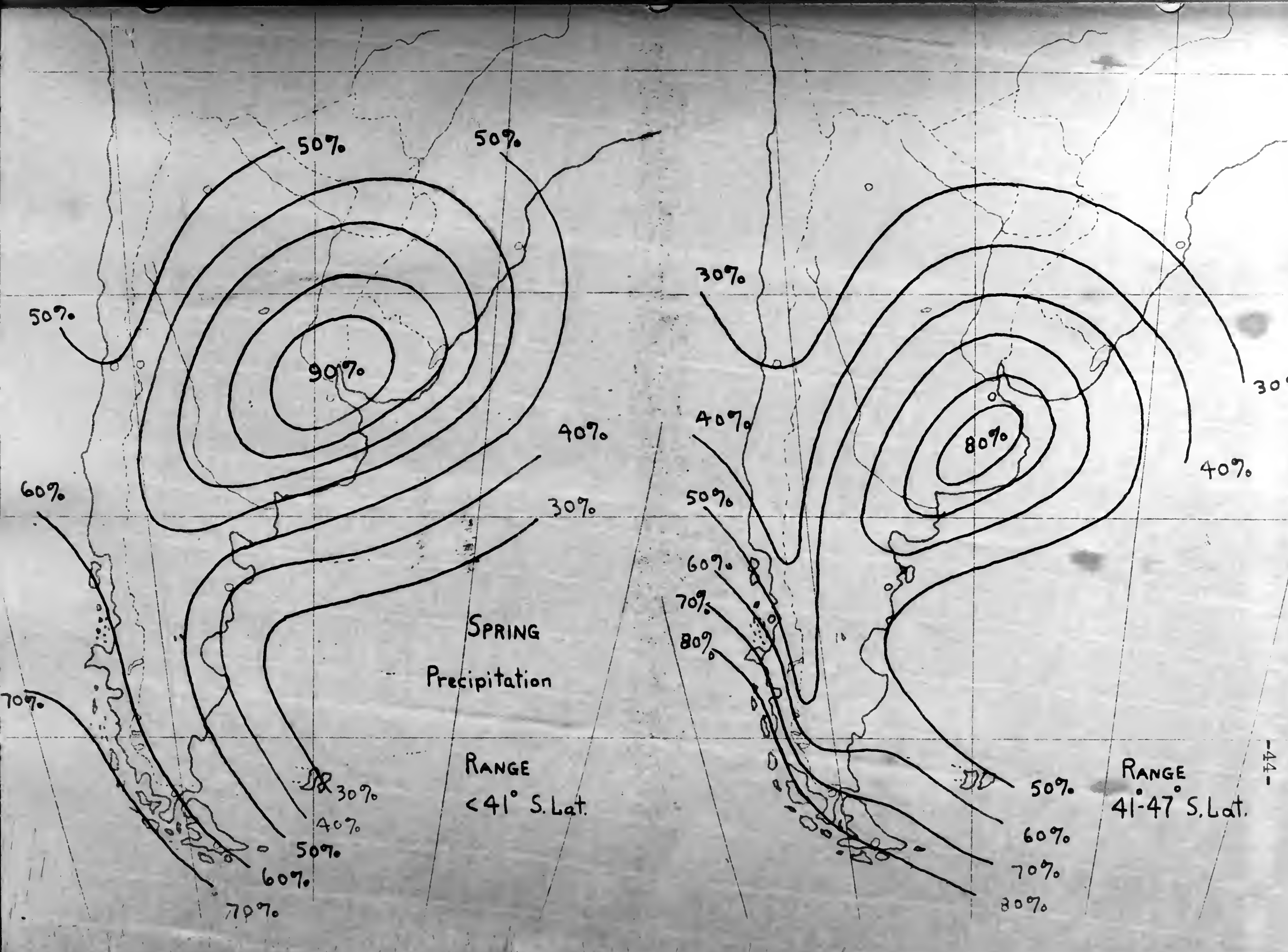


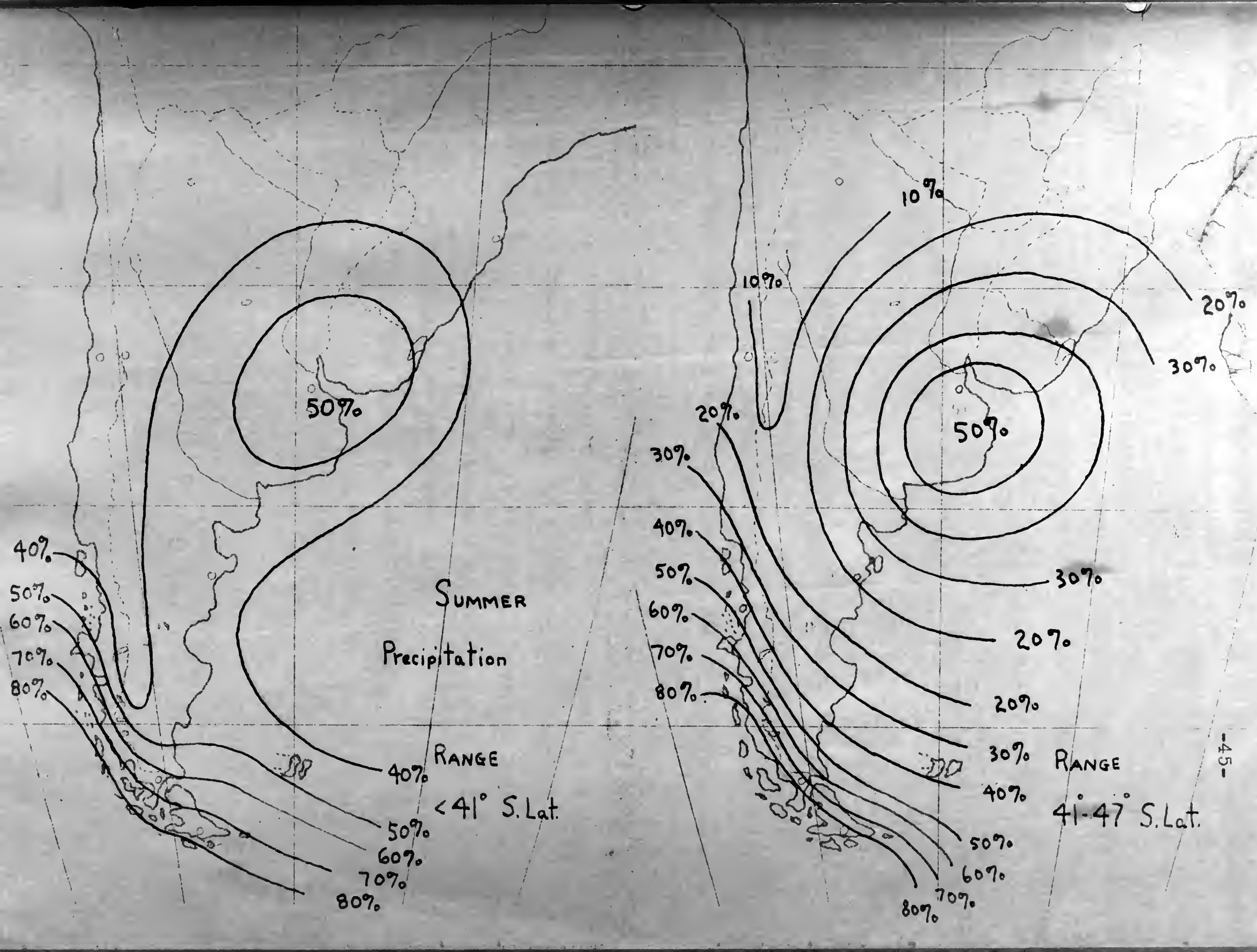

SUMMER

Temperature Changes

Maximum


SPRING
Temperature Changes
Maximum
RANGE
<41° S. Lat.
RANGE
41°-47° S. Lat.
0°
-2°
0°C.
-2°
-4°
-6°
0°C.


SPRING
Precipitation
RANGE
<41° S. Lat.
RANGE
41°-47° S. Lat.
50%
50%
50%
90%
40%
30%
60%
70%
30%
40%
50%
60%
70%
30%
40%
50%
60%
70%
80%
80%
30%
40%
50%
60%
70%
80%


Summer
Precipitation
Range
<41° S. Lat.
Range
41°-47° S. Lat.
10%
20%
30%
40%
50%
60%
70%
80%

# CONCLUSIONS

1. Due to the fact that both trough passages and storm periods show a marked peak at three days, it would seem that a set of weather type sequences should exist in the Southern Hemisphere. These sequences should last for an interval of some multiple of three days. Also supporting these shifts in the isobaric pattern, are the streamline flow charts drawn for the two months of January and July, 1941.

2. The results derived from the upper air streamline charts indicate that further charts for each month would be of benefit in studying the longer term shifts in the isobaric pattern. This pattern seems definitely to have other periods beyond the expected seasonal shift.

3. It has not been definitely shown that classification by latitude of the outbreaks crossing the Andes is possible or leads to distinct weather sequences. It is possible that, if such sequences do exist, no distinguishing feature can be recognized from the maps available at the present time. However, the latitude method seems to be the one possibility with the available maps, and should be investigated further before being discarded.

Thesis 32858
S605 Smith
Study of Argentina weather.